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PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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PHILOSOPHICAL MAGAZINE.

FEBRUARY 1799.

I. *Description of the Volcano in the Island of St. Lucia. By* M. CASSAN. *From* New Transactions of the Swedish Academy of Sciences, *Vol.* XI.

MORE volcanoes are to be found in the West India islands than in any other part of the globe; and from the frequency of earthquakes, the abundance of hot springs, &c. in these islands, there is reason to conclude that those substances which are the cause of them still exist. On account of the great quantity of sulphur produced by the mountain where this crater is situated, the name of *la Souffriere* has been given to it and to the whole adjacent district. The mountain itself forms a part of a high ridge, which runs across the whole island from north-east to south-west, and encloses the crater like a bason, which can be reached without great difficulty. Those who visit it must put on thick-soaled boots, as the earth, before they have got to the distance of two miles from the town, becomes exceedingly hot; and they must carry nothing of metal with them, and particularly silver, because their splendor is destroyed by the vapour. The sulphurised hydrogenous smell, which still increases, begins at the diftance of little more than half a mile from the town. But however ftrong this fmell may be, it feems not to be prejudicial, for the inhabitants in the neighbourhood enjoy the beft health and attain to a confiderable age. Though this diftrict is mountainous and expofed to inundations, it is very fruitful: its fugar canes produce the richeft fugar, as the diftricts around Etna and Vefuvius produce the moft celebrated wine. The nearer you approach the crater, the more numerous you find the volcanic productions. You pafs over various rivulets, the water of which has a fulphureous fmell, and the fcum feems to contain faline and ochery matter. You foon after arrive at the fide of the mountain which rifes over the volcano towards the fouth-weft. The road lies acrofs the declivity of the mountain, which is exceedingly fteep; fo that the traveller on one fide fees a terrible, almoft perpendicular, abyfs filled with abundance of vapour from boiling water by which he is furrounded, and as it were enveloped: on the other fide he is enclofed by a high fteep rock, yet one can ride without danger to that part of the mountain which enclofes the volcano on the eaft fide; but when you arrive there, you muft procure a guide, and defcend the mountain, by a very fteep path, between low thick brufh-wood. Throughout the whole way you muft beat on both fides with a ftick, in order to guard againft being bit by fnakes. Scarcely have you reached the bottom of the mountain when you find the heat of the atmofphere confiderably increafed, and the earth hot under the feet. The fulphureous vapours which here furround the body foon occafion an abundant perfpiration, and the fulphurifed hydrogenous fmell is fo powerful as to oblige many perfons to return. The valley which enclofes the volcano is about fixty fathoms long, fifty broad, and lies fixty fathoms higher than the level of the fea. It appears as if the volcano had long ago formed the hollow, in which it is fituated, by fplitting the mountain that furrounds the cavity, and by its eruption cafting to a diftance on one fide thofe parts which covered the centre or focus. In looking down into the crater great care muſt be taken that the ground, which rings below the feet, does not ſink, which would expoſe the legs to the danger of being burnt. For this reaſon it is uſual to ſend a guide before to point out the places that are ſecure, eſpecially when the weather is changeable; for people may then be ſpeedily ſurrounded by vapours tbat almoſt obſcure the ſun. It has alſo been remarked, that during rain the vapours are more abundant and thicker than at other times. It is difficult to ſay with any certainty what is the nature of the ſoil to be paſſed over in order to enter the crater; but it ſeems to conſiſt of decompoſed remains, or the ſcoriæ of different minerals, and particularly of pyrites, which however have changed their nature. As you advance farther, the ſurface of the earth appears more and more covered with ſulphur, and you find a number of ſmall ſpiracles, from which ariſes a burning vapour, and which are covered on the ſides with ſublimed ſulphur that has a very beautiful appearance. All theſe apertures may be conſidered as ſo many apparatuſes for diſtillation, which nature has prepared, in order to purify the ſulphur. If you ſtrike your ſtick againſt the ground in this ſpot, it occaſions a vent of that kind, through which the vapour iſſues with a ſtrong hiſſing noiſe, and ſo hot that it raiſes the thermometer ten degrees above the boiling point. From theſe apertures, whether the work of nature or of art, it appears that the whole ſurrounding diſtrict below the ſurface is filled with boiling water; but this water does not proceed from rain or from ſprings in the crater, but, in all probability, from the mountain which riſes above the volcano on the eaſtern ſide. This is the more credible, as the top of this mountain ends in a kind of funnel, which is of great width, and conſiſts of very marſhy ground. Several ſmall ſtreams iſſue from it alſo at different heights, and, after traverſing the ſurface of the crater, purſue their way through the valley and diſcharge themſelves into the ſea. The water of all theſe ſtreams is exceedingly warm, and is covered with a multitude of air bubbles, so that it sparkles like champagne. These bubbles exhibit all the phenomena of oxygen gas, which probably is disengaged from oxydes of various kinds with which it was combined in the earth. What among the phenomena of the crater excites most wonder are, twenty-two large basons, full of boiling water; some of which are twenty feet in diameter, and which may be considered as monstrous cauldrons placed over the most violent fire. The ebullition is so strong that water bubbles of four or five feet in height are thrown up, which raise the thermometer far above the boiling point; but this however is the case only in those where the water is from one to two feet in depth, though the depth in general amounts to eight or ten feet. You may walk round the edge of them without any danger, and contemplate at leisure this astonishing quantity of boiling water. It is of a black colour, oily, covered with scum at the edges, and diffuses a vapour which obscures the atmosphere. From this ebullition and high state of the thermometer, we might be induced to believe, that there is a great quantity of heat in these basons; but if you put your hand into the water, you find the heat less than that of boiling water. The ebullition also may proceed only from the vapours which rise from the bottom of the excavations with so much strength that they give the water a boiling movement; and, in the like manner, the rising of the thermometer ought to be ascribed to these vapours also. The surface of the ground is of a pale yellow colour, and besprinkled with a multitude of small shining crystals, for the most part crystals of sulphur. The upper part of the crater, towards the south-east, rises exceedingly steep, and is covered with a great number of other crystals lying in a kind of earth, which is partly calcareous, and partly of an unctuous nature like clay. Among these crystals there are some shaped like flat needles, and which are real crystals of sulphat of lime. Others exhibit all the properties of sulphat of alumine; others appear like sulphat of iron, greatly supersaturated with the acid;

and

and others like ferruginous pyrites covered with an efflorefcence by the action of the atmofphere and water. The above-mentioned fubftances muft be confidered as the principal caufes of the violent commotions which appear in this crater. They are fupplied from a large ftratum of pyrites; and from the violence of the combuftion, we may conjecture that it muft be very deep. It is probable alfo that this ftratum is of confiderable extent, for very hot fprings are found at the diftance of a mile both to the north and fouth of the volcano. Such fubftances accumulated in different parts of the earth, when accidentally combined with other fubftances, fuch as air, water, and inflammable bodies, produce earthquakes and other convulfions of nature. Though the internal re-action of thefe fubftances on one another feems to threaten danger, it however occafions no damage to the colony, becaufe they have immediate communication with the atmofphere, and the whole foil is penetrated by water fo that it cannot take fire: neither are coal, bitumen, or fuch inflammable bodies found in the neighbourhood.

II. *Account of the Method of Catching Wild Elephants at Tipura* in the Eaft Indies.* By JOHN CORSE, Efq. *From* The Afiatic Refearches.

IN the month of November, when the weather has become cool, and the fwamps and marfhes, formed by the rains in the five preceding months, are leffened, and fome of them dried up, a number of people are employed to go in queft of elephants.

At this feafon the males come from the receffes of the foreft into the borders and outfkirts thereof, whence they

* The ancient name of the province was *Tripura*, or *with three towns*, which has been corrupted into *Tipra* or *Tipara*.

make nocturnal excurſions into the plains in ſearch of food, and where they often deſtroy the labours of the huſbandman, by devouring and trampling down the rice, ſugar canes, &c. that they meet with. A herd or drove of elephants, from what I can learn, has never been ſeen to leave the woods: ſome of the largeſt males often ſtray to a conſiderable diſtance; but the young ones always remain in the foreſt under the protection of the Palmai, or leader of the herd, and of the larger elephants. The Goondahs, or large males, come out ſingly, or in ſmall parties, ſometimes in the morning, but commonly in the evening; and they continue to feed all night upon the long graſs, that grows amidſt the ſwamps and marſhes, and of which they are extremely fond. As often, however, as they have an opportunity, they commit depredations on the rice fields, ſugar canes, and plantain trees that are near, which oblige the farmers to keep regular watch, under a ſmall cover, erected on the tops of a few long bamboos, about 14 feet from the ground: and this precaution is neceſſary to protect them from the tigers, with which this province abounds. From this lofty ſtation the alarm is ſoon communicated from one watchman to another, and to the neighbouring villages, by means of a rattle with which each is provided. With their ſhouts and cries, and noiſe of the rattles, the elephants are generally ſcared and retire. It ſometimes, however, happens, that the males advance even to the villages, overturn the houſes, and kill thoſe who unfortunately come in their way, unleſs they have had time to light a number of fires: this element ſeems to be the moſt dreaded by wild elephants, and a few lighted wiſps of ſtraw or dried graſs ſeldom fail to ſtop their progreſs. To ſecure one of the males, a very different method is employed from that which is taken to ſecure a herd: the former is taken by Koomkees, or female elephants trained for the purpoſe, whereas the latter is driven into a ſtrong encloſure called a Keddah.

As

As the hunters know the places where the elephants come out to feed, they advance towards them in the evening with four Koomkees, which is the number of which each hunting party confifts: when the nights are dark, and thefe are the moft favourable for their purpofe, the male elephants are difcovered by the noife they make in cleaning their food, by whifking and ftriking it againft their forelegs, and by moonlight they can fee them diftinctly at fome diftance.

As foon as they have determined on the Goondah they mean to fecure, three of the Koomkees are conducted filently and flowly by their Mahotes (drivers) at a moderate diftance from each other, near to the place where he is feeding; the Koomkees advance very cautioufly, feeding as they go along, and appear like wild elephants, that have ftrayed from the jungle. When the male perceives them approaching, if he takes the alarm and is vicioufly inclined, he beats the ground with his trunk and makes a noife, fhowing evident marks of his difpleafure, and that he will not allow them to approach nearer; and if they perfift, he will immediately attack and gore them with his tufks; for which reafon they take care to retreat in good time. But fhould he be amoroufly difpofed, which is generally the cafe, (as thefe males are fuppofed to be driven from the herd at a particular period by their feniors, to prevent their having connection with the females of that herd,) he allows the females to approach, and fometimes even advances to meet them.

When, from thefe appearances, the Mahotes judge that he will become their prize, they conduct two of the females, one on each fide clofe to him, and make them advance backwards, and prefs gently with their pofteriors againft his neck and fhoulders: the third female then comes up and places herfelf directly acrofs his tail; in this fituation, fo far from fufpecting any defign againft his liberty, he begins to toy with the females and carefs them with his trunk. While thus engaged, the fourth female is brought near, with ropes and proper affiftants, who immediately get under the belly of the third female, and put a slight cord (the Chilkah *) round his hind legs: should he move, it is easily broken; in which case, if he takes no notice of this slight confinement, nor appears suspicious of what was going forward, the hunters then proceed to tie his legs with a strong cord (called Bundah †), which is passed alternately, by means of a forked stick and a kind of hook, from one leg to the other, forming the figure of 8; and as these ropes are short, for the convenience of being more readily put around his legs, 6 or 8 are generally employed, and they are made fast by another cord (the Daugbearee ‡), which is passed a few turns perpendicularly between his legs, where the folds of the Bundahs intersect each other. A strong cable (the Phand §) with a running noose, 60 cubits long, is next put round each hind leg immediately above the Bundahs, and again above them, 6 or 8 additional Bundahs, according to the size of the elephant, are made fast, in the same manner as the others were: the putting on these ropes generally takes up about 20 minutes, during which the utmost silence is observed, and the Mahotes, who keep flat upon the necks of the females, are covered with dark coloured cloths, which serve to keep them warm, and at the same time do not attract the notice of the elephant. While the people are busily employed in tying

* Chilkâ—is a very slight soft cord, which the hunters at first put around the hind-legs of a Goondah, before they begin to tie him; this is not used for Keddah elephants.

† Bundah—a middle-sized cord, six or eight cubits long, which is put round either the hind or fore legs of elephants, in order to secure them. From ten to twenty are employed.

‡ Daugbearee—is generally a continuation of every second Bundah that is put on, a few turns of which are passed round, where the folds of the Bundahs intersect each other, in order to fasten and keep them firm. When the Bundah is not long enough, another cord is made use of.

§ Phand—is a cable nearly the same size as the Dood, the noose of which is put round each leg of the Goondahs, and then it is tied to trees or stakes. The Phands, used for the Keddah elephants, are only about thirty cubits long.

the legs of the Goondah, he careſſes ſometimes one, and ſometimes another, of the ſeducers (Kootne), examining their beauties and toying with different parts, by which his deſires are excited and his attention diverted from the hunters, and in theſe amorous dalliances he is indulged by the females. But if his paſſions ſhould be ſo rouſed, before his legs are properly ſecured, as to induce him to attempt leaping on one of the females, the Mahote, to inſure his own ſafety and prevent him gratifying his deſires any further, makes the female run away, and at the ſame time, by raiſing his voice and making a noiſe, he deters the Goondah from purſuing: this however happens very ſeldom, for he is ſo ſecured by the preſſure of a Koomkee on each ſide and one behind, that he can hardly turn himſelf, or ſee any of the people, who always keep ſnug under the belly of the third female, that ſtands acroſs his tail, and which ſerves both to keep him ſteady and to prevent his kicking any of the people who are employed in ſecuring him; but in general he is ſo much taken up with his decoyers, as to attend very little to any thing elſe. In caſe of accidents, however, ſhould the Goondah break looſe, the people upon the firſt alarm can always mount on the backs of the tame elephants, by a rope that hangs ready for the purpoſe, and thus get out of his reach. When his hind legs are properly ſecured, they leave him to himſelf, and retire to a ſmall diſtance: as ſoon as the Koomkees leave him, he attempts to follow, but finding his legs tied, he is rouſed to a proper ſenſe of his ſituation, and retreats towards the jungle; the Mahotes follow at a moderate diſtance from him, on the tame elephants, accompanied by a number of people that had been previouſly ſent for, and who, as ſoon as the Goondah paſſes near a ſtout tree, make a few turns of the Phands, or long cables that are trailing behind him, around its trunk: his progreſs being thus ſtopt, he becomes furious, and exerts his utmoſt force to diſengage himſelf; nor will he then allow any of the Koomkees to come near him, but is outrageous for ſome time, falling down and goring the earth with his tuſks. If by theſe exertions the Phands are once broken, which ſometimes is effected, and he eſcapes into the thick jungle, the Mahotes dare not advance for fear of the other wild elephants, and are therefore obliged to leave him to his fate; and in this hampered ſituation, it is ſaid, he is even ungeneroully attacked by the other wild elephants. As the cables are very ſtrong and ſeldom give way, when he has exhauſted himſelf by his exertions, the Koomkees are again brought near and take their former poſitions, viz. one on each ſide and the other behind. After getting him nearer the tree, the people carry the ends of the long cables around his legs, then back and about the trunk of the tree, making, if they can, two or three turns, ſo as to prevent even the poſſibility of his eſcape. It would be almoſt impoſſible to ſecure an elephant in any other manner, as he would tear up any ſtake that could at the time be driven into the ground, and even the noiſe of doing it would frighten the elephant: for theſe reaſons, as far as I can learn, nothing leſs than a ſtrong tree is ever truſted to by the hunters. For ſtill farther ſecurity, as well as to confine him from moving to either ſide, his fore-legs are tied exactly in the ſame manner as the hind-legs were, and the Phands are made faſt, one on each ſide, to trees or ſtakes driven deep into the earth. During the proceſs of tying both the hind and fore-legs, the fourth Koomkee gives aſſiſtance where neceſſary, and the people employed cautiouſly avoid going within reach of his trunk; and when he attempts to ſeize them, they retreat to the oppoſite ſide of the Koomkees, and get on them, if neceſſary, by means of the rope above mentioned, which hangs ready for them to lay hold of. Although by theſe means he is perfectly ſecured and cannot eſcape, yet as it would be both unſafe and inconvenient to allow him to remain in the verge of the jungle, a number of additional ropes are afterwards put on, as ſhall be mentioned, for the purpoſe of conducting him to a proper ſtation. When the Goondah has become more fettled, and eat a little food, with which he is fupplied, as foon as he is taken, the Koomkees are again brought near, and a ftrong rope (Pharah *) is then put twice round his body, clofe to his fore-legs like a girth, and tied behind his fhoulder; then the long end is carried back clofe to his rump and there faftened, after a couple of turns more have been made round his body. Another cord is next faftened to the Pharah, and from thence carried under his tail like a crupper (Dooblah †), and brought forward and faftened by a turn or two, to each of the Pharahs, or girths, by which the whole is connected, and each turn of thefe cords ferves to keep the reft in their places. After this a ftrong rope (the Tooman ‡) is put round his buttocks and made faft on each fide to the girth and crupper, fo as to confine the motion of his thighs and prevent his taking a full ftep. Thefe fmaller ropes being properly adjufted, a couple of large cables (the Dools §) with running noofes are put around his neck, and after being drawn moderately tight, the noofes are fecured from running clofer, and then tied to the ropes on each fide forming the girth and crupper already mentioned; and thus all thefe ropes are connected and kept in their pro-

* Phárah—a rope that is put round the body of an elephant, like a girth, and to which the Dooblah and Dools are connected.

† Dooblah—is that rope which is made faft on one fide to the aftermoft Pharah, then carried under the tail and faftened to both the Pharahs on the oppofite fide, fo as to anfwer the purpofe of a crupper, and to keep the Pharahs in their places.

‡ Tooman—is the rope that is paffed round the buttocks of an elephant, and prevents his ftepping out freely: it is faftened to the girth and crupper, that it may not flip down.

§ Dool—is a large cable, about fixty cubits long, with a running noofe. Two of them are put round the neck of the elephant, and faftened to the foremoft Pharah or girth, one on each fide, in fuch a manner as to prevent the noofes from being drawn too tight or coming too far forward: and this is effectually done by the Dooblah; for, whenever the elephant draws back, the Dools pull the crupper forward, which muft gall him very much, and prevent him from ufing all the force he might otherwife exert, in order to free himfelf.

per places, without any riſk of the nooſes of the Dools becoming tight, ſo as to endanger the life of the elephant in his exertions to free himſelf. The ends of theſe cables are made faſt to two Koomkees, one on each ſide of the Goondah, by a couple of turns round the belly, cloſe to the ſhoulder, like a girth, where a turn is made, and it is then carried acroſs the cheſt and faſtened to the girth on the oppoſite ſide. Every thing being now ready, and a paſſage cleared from the jungle, all the ropes are taken from his legs, and only the Tooman remains round his buttocks to confine the motion of his hind legs: the Koomkees pull him forward by the Dools, and the people from behind urge him on. Inſtead of advancing in the direction they wiſh, he attempts to retreat farther into the jungle; he exerts all his force, falls down and tears the earth with his tuſks, ſcreaming and groaning, and by his violent exertions often hurts and bruiſes himſelf very much; and inſtances happen of their ſurviving theſe violent exertions only a few hours, or at moſt a few days. In general, however, they ſoon become reconciled to their fate, will eat immediately after they are taken, and, if neceſſary, may be conducted from the verge of the jungle as ſoon as a paſſage is cleared. When the elephant is brought to his proper ſtation and made faſt, he is treated with a mixture of ſeverity and gentleneſs, and in a few months (if docile) he becomes tractable, and appears perfectly reconciled to his fate. It appears ſomewhat extraordinary, that though the Goondah uſes his utmoſt force to diſengage himſelf when taken, and would kill any perſon coming within his reach, yet he never or at leaſt ſeldom attempts to hurt the females that have enſnared him, but on the contrary ſeems pleaſed (as often as they are brought near, in order to adjuſt his harneſſing, or move and ſlacken thoſe ropes which gall him), ſoothed and comforted by them, as it were, for the loſs of his liberty. All the elephants, ſoon after they are taken, are led out occaſionally for exerciſe by the Koomkees, which attend for that purpoſe.

[To be concluded in our next.

III. Qu

III. *On the Materials used for Manufacturing Cast Iron. By Mr.* David Mushet *of the Clyde Iron Works. Communicated by the Author.*

THE operation of extracting crude or cast iron from the ores is one of the least complicated processes in the art of fusion. Simply the materials are thrown into the furnace, *stratum super stratum*, and crude-iron is the result. Experience no doubt at first tutored the manufacturer, and taught him by repeated lessons the just proportions necessary for the production of certain qualities of iron.

The materials used for the manufacturing of crude-iron in this island, before the application of pit-coal, present themselves in the following order: Charcoal of wood of different kinds, primary ores of iron, with various proportions of argillaceous or calcareous iron stones. Since, charcoal or coaks made from pit-coal, argillaceous ores of iron, with small proportions of Lancashire and Cumberland ores. Calcareous stones for a flux or solvent.

In speaking of some of these separately, I shall not confine my observations to their application to use in the island of Britain alone; but treat of them as connected with the operation of fusion for the production of cast-iron in general.

Charred wood is almost universally used throughout the Continent, as fuel for the production of cast-iron. From its great abundance in the northern countries, the discovery of pit-coal would be deemed of little advantage for many years to come *. The extensive woods in Siberia and Sweden afford a constant supply of fuel to the numerous iron works in those countries. The necessary regulations which the respective governments of each country have thought proper to enact, will in all probability preserve, during their existence, the necessary supply of fuel for the manu-

* Pit-coal has been discovered in Siberia of various qualities and in great abundance, fit for the same purposes to which it is applied in this country.

manufacturers *. If the woods receive necessary care and attention after the first cutting, they will replace themselves at periods from 15 to 18 years. The charcoal used in Siberia is all made from the pine and larch, the country affording no other varieties of timber. In Sweden the manufacturers are supplied with a considerable proportion of harder woods, which is greatly in favour of the manufacture.

It has been already noticed, in a former paper, that the fuel used in Britain at an early period, and so far down as the beginning of the present century, chiefly consisted of wood. The kinds of wood used for this purpose were various; but char of hard wood, such as oak, birch, ash, &c. &c. was always preferred to that made from pine, holly, sallow, &c. &c. At the small remaining number of charcoal furnaces now in this country, the oak has still the undoubted preference. Its firmness and continuity enable it in the blast furnace to support and convey principle to the iron contained in a larger portion of ore, than charcoal made from softer wood. The same properties also enable it for a time to sustain a heavier pressure of air from the discharging pipe: this facilitates the reduction of the whole, and greatly augments the weekly produce in iron. The mode of preparing charcoal of wood for the blast-furnace, though extremely simple, is yet capable of being greatly misunderstood, so as to occasion a considerable waste of wood in the process. The following is the detail of an operation which I have seen successfully tried, and which was productive of excellent charcoal. It is the same I believe as is followed at the two charcoal furnaces in Argyleshire.

First of all, a plot of ground is raised a little higher than

* In Sweden there is a law restricting the manufacturers of iron to a certain annual produce; and this quantity is always in proportion to the ground attached to the work. In this manner the wood is enabled to replace itself at certain intervals; and each work is insured of an annual though moderate supply. The more extensive and unpeopled tracts of Siberia, render such exactitude in the execution of the laws less necessary.

the surrounding surface: this is made slightly convex. The burner commences by placing in the centre a circle of sticks, transversely inclining, and crossing each other near their tops. Around these are built successive circles of wood of various sizes, from 1 to 10 inches diameter; but care is always taken to place those of similar diameters in the same circle. A round of beams, of the largest nature, is immediately followed by one so much smaller as to fill up the interstices between the larger diameters, that no more air may be admitted than is necessary to excite gradual combustion. These are again followed by pieces of an increasing diameter. This mode of ranging the large and small sizes is continued till such time as the pile is deemed sufficiently large. The total width may then measure from 20 to 30 feet. The last layer is commonly composed of small brush-wood. The whole is then covered with turf, the grassy side towards the wood; a coating of earth is then applied all round the bottom of the pile, and firmly beat to prevent the unnecessary admission of air. A small funnel, or opening on the top, is preserved by the transverse position of the first layer of wood; this is generally about 18 inches deep, into which the burning fuel is introduced. Combustion is in this manner first conveyed to the top of the pile, and is continued by feeding the small craters with pieces of wood for 4 or 5 days. When the interior part of the fire next the top is deemed sufficiently kindled and spread over the whole diameter, a row of holes is opened a few inches below, each about two inches diameter. The hole at the top is then entirely shut up, and the fire, now completely spread, slowly descends to where the air is admitted by means of the small apertures. When this is observed by the burner, which is known by the disappearance of smoke and vapour, they are immediately shut up, and a second row opened 6 or 8 inches under the first. In this manner the fire is conducted to the foundation of the pile, and the whole mass exposed to proper combustion. The intention of the operation is to bring the whole pile to a state of complete ignition, but in such a

manner

manner that no greater a portion of it may undergo combustion than is neceffary to produce that effect. Hence the neceffity for guarding againft too free an accefs of air during the procefs. As foon as the operation is ended, which may laft for 10 or 14 days, the whole is more clofely covered up, and kept fo till fuch time as the char is deemed fufficiently cool to be fit for drawing: it is then feparated from the earth, and carried away in bags or in waggons. Thofe pieces of wood not fufficiently charred are by the workmen called *brands*, and are commonly ufed for fuel to the next fire.

The lofs of weight in charring wood is inconceivably great. In the large way it is almoft impoffible to afcertain it to any degree of exactnefs. The qualities of wood are fo various, and the tendency which fome have beyond others of parting with their juices, even when expofed to the fame temperature, render it at beft but a matter of dubiety. I fhall however infert a few which I have charred in the fmall way, and the refults obtained from them; before weighing they were all expofed to the fame temperature for a confiderable time, and thoroughly dried.

It is however worthy of remark, that the produce in charcoal in the fmall way, does not give an invariable ftandard whereby to judge of that obtained on a large fcale, where ignition is caufed by the admiffion of external air into contact with the wood. In the large way the quantity of char afforded will depend more upon the hardnefs and compactnefs of the texture of wood, and the fkill of the workman, than on the quantity of carbon it contains. In the following tables I have fimply expreffed the exiftence of the alkaline principle, in the various afhes obtained from the combuftion of 1 pound of wood avoirdupoife weight: this may be of ufe to thofe who wifh to make experiments upon the formation of pot-afh. It will alfo be obferved, that there are fome woods that yield a much larger proportion of carbon than oak: thefe, however, are either too fcarce or too valuable to be applied to the manufacturing of iron in this country.

TABLE

TABLE of the component Parts of 1 English Pound Avoirdupoise, or 7000 Troy Grains of the following Varieties of Wood.

	Water, Hydr. gas, Carb.acid.	Carbon	Ashes	Colour and Degree of Saturation of the Alkaline Principle.
Oak - -	5382,6	1587,8	29,6	Grey, sharply alkaline.
Ash - -	5688,2	1258,0	53,8	Whitish blue, do.
Birch - -	5650,2	1224,4	125,4	Brownish red, do.
Norway Pine	5630,9	1344,3	24,8	Brown, not in the least alkaline.
Mahogany -	5147,00	1784,4	68,6	Grey, sharply alkaline.
Sycamore -	5544,00	1381,4	74,6	Pure white, weakly do.
Holly - -	5524,4	1394,3	81,3	Do. sharply do.
Scotch Pine -	5816,7	1151,9	31,4	Brown, perceptibly do.
Beech - -	5537,3	1395,9	66,8	Greyish white, sharply do.
Elm - -	5576,6	1370,2	53,2	Grey, partially do.
Walnut - -	5496,5	1446,4	57,1	Pure white, light as down, weakly do.
Americ. Mapple	5553,2	1393,1	53,7	Dark grey, sharply do.
Do. Black Beech	5425,9	1301,8	72,3	Brown, do.
Laburnum -	5196,4	1721,0	82,6	White and grey, partially alkaline.
Lignum Vitæ	5083,00	1880,0	35,0	Grey, sharply do.
Sallow - -	5626,00	1294,8	79,2	Light grey, do.
Chesnut - -	5341,3	1629,6	29,1	Grey, do.

Parts in 100.

	Water, Hydr. gas, Carb.acid.	Carbon	Ashes	Colour, Nature, Compactness of the Charcoal.
Oak - -	76,895	22,682	,423	Black, close and very firm.
Ash - -	81,260	17,972	,768	Shining black, spongy, moderately firm.
Birch - -	80,717	17,491	1,792	Velvet black, bulky and do.
Norway Pine	80,441	19,204	,355	Shining black, bulky and very soft.
Mahogany -	73,528	25,492	,980	Tinged with brown, spongy, and firm.
Sycamore -	79,200	19,734	1,066	Fine black, bulky and moderately firm.
Holly - -	78,920	19,918	1,162	Dull black, loose and bulky.
Scotch Pine -	83,095	16,456	,449	Tinged with brown, bulky but pretty firm.
Beech - -	79,104	19,941	,955	Dull black, spongy, but very firm.
Elm - -	79,655	19,574	,761	Fine black, moderately firm.
Walnut - -	78,521	20,663	,816	Dull black, texture close, body firm.
American Mapple	79,331	19,901	,768	Dull black, texture close, moderately do.
Do. Black Beech	77,512	21,455	1,033	Fine black, compact and remarkably hard.
Laburnum -	74,234	24,586	1,180	Velvet black, do.
Lignum Vitæ	72,643	26,857	,500	Greyish, resembles pit coal, coaks, do.
Sallow - -	80,371	18,497	1,132	Velvet black, bulky, loose and soft.
Chesnut - -	76,304	23,280	,416	Glossy black, compact and firm.

The advantages that charcoal poſſeſſes, beyond thoſe of pit-coal, for the manufacturing of crude iron, are derived from the purity of its component parts, and the ſuperior quantity of unalloyed carbon it affords to the iron. This principle is preſented to the metal free from the combination of clay, lime, ſand, and ſulphur; with which pit-coal frequently abounds. A determinate quantity of charcoal by meaſure, will ſmelt and convey principle to three times the quantity of iron that can be done by the ſame meaſure of pit-coal coaks. Its greateſt and moſt uſeful property, however, ſeems to be developed in the refinery fire, and ſimilar bar-iron operations; where it manifeſts in the moſt evident manner its ſuperiority over pit-coal, by ſhortening the tedious proceſſes of the forge, diminiſhing the waſte, and affording a much ſuperior quality of iron for all the purpoſes of ſubſequent manufacture.

Pit Coal.

No ſooner had the conſequences of the general diminution of wood, for the purpoſe of making charcoal, been felt by individuals, whoſe intereſt it was to ſupport the fabrication of iron, than their violent prejudices were laid aſide againſt the uſe of pit-coal, and this mineral combuſtible ſubſtance was brought forward, and eſtabliſhed as the baſis of a profitable and uſeful manufacture.

Pit-coal has hitherto been better known, and its uſefulneſs made more ſubſervient to the purpoſes of life and of manufacture in Britain, than in any other country. This valuable fuel is generally found in ſtrata of various dimenſions, and of various inclinations from the parallel of the horizon. It is alſo found, though ſeldom, in vertical maſſes irregularly diffuſed, and leſs extenſive than the former. Regular ſtrata widely extended are found from 2 to 10 feet in thickneſs; thoſe moſt commonly met with are from 3 to 6 feet*.

* There is at Dyſart in Fifeſhire a regular ſtratum of coal upwards of 24 feet thick, and is the thickeſt ever heard of in this country.

The

The pit-coal in Scotland may be arranged under the following claſſes, of each of which there are many varieties: ſplint coal, free coal, and bituminous coal. To the former a juſt preference has always been given, for the ſuperior effects it produces in the blaſt-furnace. Free coal ſeems to partake of the nature of the ſplint and the bituminous coal, and is frequently found interſperſed with ſmall layers of ſplint. It ought therefore to be conſidered as the medium ſtate of the mineral. Under bituminous coal may be arranged the lighter varieties, known by the names of candle-coal, parrot-coal, &c. Theſe hitherto have been deemed unfit for the manufacturing of crude iron in any profitable ſhape.

As in this place I mean only to convey a juſt idea of the materials uſed in the ſmelting proceſs, I ſhall not enter into a comparative view of the relative effects which the various qualities of coal produce, when uſed in the ſmelting or caſting-furnace; but confine my deſcription to that quality which can be uſed for manufacturing crude iron to advantage. Of this kind there are two varieties; the pure ſplint and a mixture of ſplint and free coal, generally compoſed of alternate ſtrata of each. Both theſe poſſeſs their advantages derived from local conſtruction; the former being the moſt preferable, where a ſuperiority of mechanic power affords the furnace a heavy and unremitted ſupply of air. The latter will be found to poſſeſs equal advantages, where a deficiency of power in the air machine conveys to the furnace but a ſparing column of blaſt. The purer and the more approaching to ſplint is the coal, the more capable will it be of ſupporting unſhaken a current of highly compreſſed air, and of conveying the carbonaceous principle to the iron; which ſtamps its utility and value. On the contrary, the ſofter and leſs connected the coal, the leſs capable is it of reſiſting the force of the blaſt, and of ſupporting a certain proportion of ore till ſuch time as the metal which it contains imbibes the coally principle, ſo eſſential to its existing as melting pig-iron; and which is always effected previous to separation—of course before the mixtures ought to come in contact with the blast.

To these general data, the following quality of coal found in different places in England and Wales claims exception. This coal is composed of a very small proportion of bitumen, and contains more carbon than any of the Scotch coals hitherto discovered. To the purity of the splint-coal it unites all the softness and combustibility of wood. The effects produced by it in the blast-furnace, either as to quantity or quality of cast-iron, far exceed any thing in the history of the manufacture of that metal with charcoal. At present there is one furnace in Wales that yields 60 tons of pig-iron upon an average weekly.

In preparing pit-coal for the blast-furnace, well understood among manufacturers by the term coaking, flat surfaces are appropriated. These are firmly beat and puddled over with clay, so as to pass the necessary cartage without furrowing or loosening the earth. These spaces form squares, more or less oblong, and are called hearths; upon which the pieces of coal are regularly placed inclining to each other. Great care is taken to place each piece upon the ground layer on its acutest angle, in order that the least surface possible may come in contact with the ground. By this means large interstices are preserved for the admission and regular communication of the air necessary to excite and effect complete ignition.

The quantity of coaks charred in one heap or hearth, is various at different, and even at the same works. Forty tons of coals is amongst the smallest fires, and some hearths again will admit of 80 or 100 tons. The length of the fire is in proportion to the quantity of coals built: the breadths and heights are also subject to no determinate standard; but are from 30 to 50 inches high, and from 9 to 16 feet broad. In building each fire, they reserve a number of vents

reaching

reaching from top to bottom, into which the burning fuel is introduced. This is immediately covered by ſmall pieces of coal beat hard into the aperture: theſe repreſs the kindling fire from aſcending, and oblige it to ſeek a paſſage by creeping along the bottom, which is moſt expoſed to air. In this progreſs the fire of each vent meets, and, when united, riſe gradually, and burſt forth on all ſides at once.

If the coal contains pyrites, the combuſtion is allowed to continue a conſiderable time after the diſappearance of ſmoke; the ſulphur then becomes diſengaged, and part of it is found in flowers upon the ſurface of the heap. If the coal is free from this hurtful mixture, the fire is covered up in a ſhort time after the ſmoke diſappears; beginning at the foundation, and proceeding gradually to the top.

The length of time neceſſary to produce good coaks depends upon the nature of the coal to be coaked, and the ſtate of the weather. In 50, 60 to 70 hours the fire is generally completely covered over with the aſhes of char formerly made: the coaks, thus entirely ſecluded from air, ſoon cool, and in 12 or 14 days may be drawn and wheeled to the furnace.

It is with pit-coal, in a great meaſure, as with wood, in the proceſs of charring. Coals do not always afford a weight of coaks in proportion to the quantity of carbon in the coal. It depends more upon the capability of the coal to reſiſt the waſte occaſioned by combuſtion, ſupported by external air, than upon the real quantity of carbon inherent in the coal; as may be ſeen by comparing the loſs of weight which coals undergo in the large way, and the reſults obtained from the ſame coals, by burning them unexpoſed to external air in the ſmall way.

The loſs ſuſtained in coaking coals fit for the purpoſe of manufacturing, or melting iron, is found to be nearly as follows;

2240 pounds of free coals - - yield 700 lbs. coaks, loſs 1540 lbs.
2240 - - of ſplint and free coal mixt - 840 lbs. coaks, loſs 1400 lbs.

2240 pounds of splint slightly mixt yield	1000 lbs. coaks,	loss	1240 lbs.
2240 - - of pure splint - - -	1100 - -	loss	1120 lbs.

This great weight thus lost is chiefly carried off in smoke. If a vessel is placed, filled with cold water, in the midst of one of these massy columns of vapour, before the fire has penetrated to the surface of the heap, a considerable quantity of tar will condense upon its external surface: this will continue to increase till such time as the water assumes the temperature of the smoke. At many iron works from 300 to 1000 tons of coals are thus weekly reduced to cinder. What a prodigious quantity of bituminous vapour, surcharged with tar, ammoniac and oil, must for the present be lost!!

I have found the specific gravities of the above coals and coaks to be as follow:

	Sp. Gr.	lbs. Avoirdup.		Sp. Gr.
Bituminous coal -	1·1801—Cubic foot	72·60—the coak		·3985
Free coal and little splints	1·1954—Ditto	73·75 —Ditto		·4798
Mixture splint and free	1·2307—Ditto	76·91—Ditto		·6547
Pure splint - -	1·3121—Ditto	82·02—Ditto		·9533

Results obtained from the same coals by ignition unexposed to external air:

Bituminous coal 100 pts. comp. of Bitn.	51·5	Carb. 3·65	Ash. 12	S.g. ·4534
Free coal, pure - - - -	44·8	- 53·45	- 1,75	- ·4827
Mixture of free and splint - - -	45·5	- 51·2	- 3,3	- ·6698
Pure splint - - - -	42·4	- 53·4	- 4,2	- ·9599

The comparative quantity of coaks produced from 100 parts in both ways will stand thus:

Bituminous coal coaked in air	31·20	Coaked, unexposed to air	49·5
Pure free coal and a little splint	37·50	Ditto - - -	55·2
Splint and free coal - -	44·59	Ditto - - -	54·5
Splint, pure - - -	49·10	Ditto - - -	57·6

These experiments were performed on coals found immediately in this neighbourhood, part of which are used in the manufacturing of iron. The qualities of coal, however, even of the same seam, vary in different places.

Iron-

Iron-stone.

The substitution of pit-coal in the blast-furnace, in place of the charcoal of wood, first introduced to general use those numerous strata of argillaceous iron ores found stratified along with the other secondary formations of our globe. The intimate connection which nature had imposed upon these two mineral substances, by the plentiful formation of them, almost always within convenient reach of each other, has been successfully traced and beneficially developed in their mutual application to the manufacturing of cast-iron.

Had nature not formed this immense store of iron so congenial to the use of pit-coal combined in its present form, the application of cast-iron to the various branches of machinery, and to the vast variety of useful and ornamental castings constructed for the conveniences and elegancies, had been greatly retarded, if not hitherto altogether kept back. At present it is by many believed—nor has any attempt in the large way ever contradicted it—that primary ores of iron, such as the Cumberland and Lancashire ores, are incapable of affording cast-iron sufficiently carbonated, when smelted alone with pit-coal coaks, to be re-melted to advantage in the manufacturing of castings *. Certain it is that a larger por-

* I have not heard of any attempt to produce carbonated cast-iron from these ores in the large way. The universal diffusion of iron-stones renders this superfluous; especially as the use of Cumberland and Lancashire ore can only extend to the neighbourhood, or at most can only be used by strangers whose works are within the reach of water-carriage. Their advantage therefore would only be local, and their utility restricted by the expence of carriage, of freight, or of both. As to the quality of iron they contain, I have not a scruple in asserting, that it can be called into existence by means of the assay-furnace sufficiently carbonated, even to excess, for any purpose. From these ores I have obtained reguli of supercarbonated crude iron covered with numerous specks of plumbago. The same results being obtained from iron-stones in the same manner, though with a different application of solvents, am I not at liberty to deduce, that similar effects could be produced in the large way, by varying the treatment and proportion of materials? Vide Assaying of Primary Ores by Fusion.

tion of coaks is at all times neceſſary to correct the bad effects which theſe ores, eſpecially the former, would otherways produce in the blaſt-furnace, though uſed in very ſmall quantities.

Thoſe iron-ſtones with which Britain ſo much abounds, and which are now univerſally uſed for the production of caſt-iron with pit-coal, are commonly found in horizontal ſtrata, ſubject to the ſame acclivity and declivity with the other ſtratified ſubſtances under the ſurface; their inclination from the horizon varying according to the nature of the ground, and the diſpoſition of the imbedding and incumbent ſtrata. Such variety is exhibited, that ſtrata of iron-ſtone are found deſcending 1 yard in 24, 1 in 12, 1 in 8, and ſometimes 1 in 4. Let AB (Plate I. Fig. 7.) repreſent a line drawn parallel to the horizon, and CD a ſtratum of iron-ſtone. Suppoſe the horizontal line continued for 24 yards: at that diſtance the iron-ſtone will be found to have deſcended one yard of perpendicular meaſure, at the termination of the lines AB, AD; and if the ſame line is ſuppoſed to meaſure 4 or 8 yards, it will repreſent thoſe ſtrata that are arranged at a more diſadvantageous declivity. From this it is obvious, that where the acclivity or declivity of the metals is ſmall, the moſt extenſive and regular fields of iron-ſtone are to be found, and *vice verſa* where the metals lay more on edge.

Iron-ſtones are generally found imbedded in ſchiſtous clay more or leſs compact, but which moulders away when expoſed to air. They aſſume two different forms: regular connected ſtrata called bands, and ſtrata of detached ſtone found in diſtinct maſſes, from the ſize of the ſmalleſt bullet to the weight of ſeveral hundred pounds. Thoſe of the ſmall and middling ſizes, and which generally wear a flat ovular form, are called ball-ſtones: thoſe of greater weights are by the workmen denominated *lunkers*.

Both theſe ſpecies of iron-ſtone frequently accompany coal and limeſtone. In the former caſe they are commonly incumbent, and found almoſt in immediate contact with the coal:

coal: little extra labour is therefore requisite to bring down the stone; and the double purpose of obtaining both materials is thus advantageously answered.

When ironstone in bands accompanies limestone: it is most commonly of an inferior quality. Its component parts are chiefly calcareous, and the quantity of iron it contains is small. Ball ironstones found near to lime are of a much superior quality, and for the most part contain a considerable proportion of iron.

Thus stratified in the vicinity of lime, many ironstones are found with various impressions of marine remains; and not unfrequently compact and entire shells, univalve and bivalve, are found in the heart of the band. It is however still more difficult to conceive how shells could be deposited, distant from lime, imbedded in ironstone, incumbent on coal, at the great depth of 80 yards from the surface. In our neighbourhood, at this depth, a small band of ironstone is found completely covered and interspersed with distinct muscles of an ordinary size.

Among the great variety of rich ironstones found in Lancashire, the Rottenburn stone challenges particular attention, for the beautiful specimens it affords of vegetable decomposition and impression. This stone consists of a band and an accompanying ball. The former abounds with fine specimens of the ramification of trees, shrubs, &c. In the process of decay, and the substitution of mineral in place of vegetable substance, the more ligneous parts and the bark are distinctly preserved from the heart of the shoot. The former are found of a proper thickness, consisting of pure calcareous earth, encircling the central parts, which commonly have been displaced and occupied by the same compound as the general mass. As the external parts of the vegetable seem to have been laterally formed, it is presumed that they have withstood the decomposition of the softer parts, and have only been displaced afterwards by a filter which has contained calcareous earth in solution. This iron-stone contains 37 lb. in in 100 extremely ſuſceptible of receiving the carbonaceous principle.

The ſtratum of detached ſtone is externally marked with vegetable impreſſions, from the ſize of trees to ſmall branches. The exterior appearance of this ſtone greatly reſembles wood dug from a moraſs or bog, with knobs or excreſcences of various ſizes. Theſe ſtumps are from 9 to 18 inches long, and are oval or round of various diameters: they ſplit lengthways like a piece of wood, and their internal ſurfaces exhibit the moſt perfect traces of their original formation. In moſt of them the fibres, as in wood, are ſeen running lengthways, and a croſs ſection preſents the commencement of ſhoots of various thickneſſes. In one of them I found a diſtinct nut, and a piece of the filament ſtill in a vegetable ſtate. The ſame piece of ſtone afforded a confuſed coagulation of mineral and vegetable ſubſtances. In the aſſay this ball-ſtone yielded me $40\frac{5}{6}$ per cent. of iron.

Another variety of iron-ſtone, which we have in this country, and which will be deemed no leſs curious by the mineralogiſt, affords maltha, bitumen, mineral pitch, &c. This combuſtible is found in the heart of large flat rounded balls of iron-ſtone, occupying a number of interſtices, and reſembling a cement for the frittered pieces of ſtone. It is commonly found attached to pure calcareous ſpar, which has alſo found its way into theſe vacuities. I obſerved that where the ſpar was thickeſt, the bitumen was proportionally thin; in ſome places it totally diſappeared, and the chaſm became entirely filled with ſpar: this led me to conjecture, that the deſtruction of the bitumen was effected by the filter which had depoſited the lime it held in ſolution; and that even at the time the ſtone was dug, nature was employed in this progreſſive and tedious operation. I have found ſome pieces of plant along with the bitumen, which reſemble that from which ſoda is made; thoſe, though preſerved in ſhape, were equally inflammable with the pitch. The diſtillation of 437 grains afforded me a rough light charcoal, which weighed

only

only 49 grains; this, when expofed to fire in contact with air, burnt without a refidue; hence I conclude it to be pure carbon. This iron-ftone in the affay-furnace yields 36 pounds of iron in 100.

All thefe ftrata of iron-ftone bear the moft evident marks of the agency of water. It is not fo difficult to conceive how regular ftrata of iron-ftone fhould be formed by the depofition of water: but how fuch huge maffes, broken off, detached, rounded and impreffed with various external fhapes, abounding with the forms of fubftances formerly foreign, now tranfpofed, and forming part of the fame mafs; regularly depofited in ftrata, fometimes incumbent, fometimes decumbent to lime, coal, and their own fpecies, is a work of real admiration; in attempting to folve which, conjecture muft fupply the place of certainty, and analogy muft ferve in place of ftrict demonftration.

The manner and difpofition of the Rottenburn ball iron-ftone refembles more an irregular diffufion of wood, felled into lengths, and afterwards changed to ftone; than a regular ftratification, depofited by the decompofition of water, or the efcape of an acid.

The phenomena attending water depofiting matter in folution, and of transforming the nature of vegetables, wood, &c. I have frequently and fatisfactorily obferved. Within the laft four months I have obtained ftrata of an inch thick, whofe furface, expofed to the action of the water, difplayed an entire covering of calcareous cryftals of an ice colour, fo fmall as not to be diftinguifhed by the naked eye. The fracture of fuch a thicknefs prefents from 12 to 15 various-coloured ftrata fucceffively depofited; chiefly lime, with a fmall portion of fine filex and magnefian earth. By expofing it a few days to drynefs, it acquires confiftency and firmnefs almoft equal to limeftone. Heat is requifite to difengage this fediment. Its affinity in this cafe is greateft to wood, lefs to iron, and leaft of all to lead. Pieces of wood boiled in this water become foftened: the liquid penetrates to the heart of

the

the piece, opens the pores of the wood, and admits the particles of matter. By this accumulation of weight the wood finks, and in 15 to 18 days a foft flime is formed over all its furface; this gradually hardens into a cruft, and diffufes itfelf inwards: during the progrefs of formation the flimy matter which is next to the wood receives the impreffion of the fibres, and communicates their form to the mafs. Hence impreffions are conveyed to ftones, which are afterwards formed when in a compact ftate.

I am afraid it will be thought that I have exceeded the limits I propofed to myfelf; but the few particulars I have related concerning the depofition of matter from water may tend to explain fome part of the phenomena attending the formation of fome iron-ftones. I fhall probably on a future occafion give fome further obfervations concerning the effects of this water, and the progrefs it makes in fubftituting one fpecies of matter in the room of another, and in the formation of ftrata.

Working of Iron-ftone.

When iron-ftone is found near the furface, it is only neceffary to unbare the foil and the fuper-incumbent earths: the ftone then prefents itfelf like a pavement more or lefs inclined, and is eafily raifed by the application of wedges, bars, &c. &c. But as all fecondary ftrata defcend, according to the declivity impofed upon them by nature in their formation, it is obvious that, in proportion as the excavation extends at right angles to the line of level, the ftone becomes gradually buried under an accumulating depth of earth, till fuch time as the expence of throwing this off exceeds either the value of the ftone, or the expence at which it could be procured by a different mode of operation. It therefore becomes neceffary to make perforations by means of horizontal galleries, extended under the foil, fo as to fall in with the declivity of the ftrata: thefe catch the inclining ftone for a ftretch of 100 to 240 yards, according to the exiftent circumftances of the mine.

Thefe

These galleries are in Scotland called the barrow roads. Whenever the miner has arrived at the extremity of his working, he turns round, and commences an excavation on his right and left hand, proportioned to the rife and dip of the ftone, to the extent of feveral yards on each; the accompanying fhift and rubbifh are packed into the vacuity behind him: fhould there remain any fuperfluity unpacked, it is wheeled to the mouth of the gallery along with the iron-ftone. In this manner the miner returns, and brings along with him the whole iron-ftone contained in 100 to 240 yards in length, and in 20 to 30 yards in width. The height of the gallery is commonly fo fmall, that the miner is obliged to perform his work upon his fide: the wheelers are likewife obliged to pufh the barrow on all fours. This fpecies of working is called under cover; and the attainment of a band of good iron-ftone, though only four inches thick, will fufficiently defray the expence of the operation. It is here alfo obvious, that this operation can only be carried a certain length in the fame gallery, till fuch time as the expence of wheeling out the ftone muft exceed the value of that fhare of labour generally appropriated to it. A more economical method is therefore indifpenfibly requifite. This is effected by finking a pit 160 to 200 yards farther on the fame line of level. When the iron-ftone is found, the miner fets off another gallery, or bar ow r ad, towards his former working, and continues till he meet the termination of his *old wafte:* as formerly, he now begins his retreat, and carries with him a fimilar portion of iron-ftone from each fide of the gallery. The quantity of iron-ftone by weight obtained from fuch a *working*, depends entirely upon its extent and the thicknefs of the band. A fquare yard of iron-ftone containing 9 cubical feet, as it lays ftratified, will weigh from 1850 to 1900 pounds weight. The other fide of the pit is next perforated, and the fame operation completed. When the iron-ftone is thus exhaufted, another pit funk at a fimilar diftance from the termination of the fecond

cond gallery in the first, opens up a new field of supply. In this manner iron-stone is continued to be raised, till such time as the *field* is totally exhausted.

These extensive excavations commonly collect a considerable quantity of water, which would soon impede the progress of the workmen: various means have been contrived to remove this consequent obstruction. These have chiefly consisted in running a counter gallery as far to the declivity of the *metals* as possible, and of passing the water into it by means of filtration, or communications betwixt gallery and gallery. Where a sufficient quantity of running water presents itself, water-wheels have been applied, to extract the water from one general reservoir by means of pumps.

Strata of iron-stone are from ½ an inch to 12 inches in thickness. Those of 3, 4, 5 and 6 inches are most commonly met with; they are also reckoned to contain a quantity and quality of iron superior to larger bands. Ball and lunker iron-stone, however large, contain always a superior quantity of iron, and are easier reduced in the blast-furnace.

IV. *On Preserving Seeds of Plants in a State fit for Vegetation.* By JOHN SNEYD, *Esq. of Belmont, Staffordshire. From the* Transactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

MANY years ago having observed some seeds which had got accidentally amongst raisins, and that they were such as are generally attended with difficulty to raise in England after coming in the *usual way* from abroad, I sowed them in pots, within a framing; and as all of them grew, I commissioned my sons, who were then abroad, to pack up all sorts of seeds they could procure in absorbent paper, and send some of them surrounded by raisins, and others by brown

brown moift fugar; concluding that the former feeds had been preferved by a *peculiarly favourable ftate of moifture* thus afforded to them. It occurred, likewife, that as many of our common feeds, fuch as clover, charlock, &c. would lie dormant for ages within the earth, well preferved for vegetation whenever they might happen to be thrown to the furface, and expofed to the atmofphere, fo thefe foreign feeds might be equally preferved, *for many months at leaft*, by the kindly covering and genial moifture that either raifins or fugar afforded them: and this conjecture was really fulfilled, as not one in twenty of them failed to vegetate; when thofe of *the fame kinds*, that I ordered to be fent lapped in common parcels, and forwarded with them, would not grow at all. I obferved, upon examining them all before they were committed to the earth, that there was a prevailing drynefs in the latter, and that the former looked frefh and healthy, and were not in the leaft infefted by infects, as was the cafe with the others. It has been tried repeatedly to convey feeds (of many plants difficult to raife) clofed up in bottles, but without fuccefs; fome greater proportion of air, as well as a proper ftate of moifture, perhaps, being neceffary. I fhould alfo obferve, for the fatisfaction of the Society, that no difference was made in the package of the feeds, refpecting their being kept in hufks, pods, &c. fo as to give thofe in *raifins* or *fugar any advantage over the others*, all being fent equally guarded by their natural teguments. Whether any experiments of this nature have been made by others, I am totally ignorant; but I think that, fhould this mode of conveyance be purfued ftill more fatisfactorily than I have done, very confiderable advantages might refult from it.

V. *A quick and eafy Method of converting Weeds and other Vegetable Matter into Manure. By Mr.* BROWN *of Derby. From the* Tranfactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

I BEG leave to communicate to the Society, and, if thought worth notice, by them to the world, a compofition for manure. Fearful it would not anfwer the purpofe fo fully as I could wifh, I deferred it from year to year; but I now find, both by numerous trials made by my friends, as well as myfelf, the very great utility of the compofition, as well as its cheapnefs, with the capability of its being made in any fituation and in any quantity. The mode of making it is as fimple as, I truft, it will be found productive. It is nothing more than green vegetable matter, decompofed by quick or frefh-burnt lime. A layer of the vegetable matter about a foot thick, then a very thin layer of lime, beat fmall, and fo on; firft vegetable, then lime, alternately. After it has been put together a few hours, the decompofition will begin to take place; and unlefs prevented, either by a few fods, or a forkfull of the vegetables at hand, it will break out into a blaze, which muft at all events be prevented. In about twenty-four hours the procefs will be complete, when you will have a quantity of afhes ready to lay on your land at any time you wifh. Any and all forts of vegetables, if ufed green, will anfwer the purpofe; fay weeds of every defcription. They will doubly ferve the farmer, as they will not only be got at a fmall expence, but will in time render his farm more valuable, by being deprived of all noifome weeds.

But if this compofition anfwers the purpofe, as I flatter myfelf it will, a very fhort time will fee almoft every weed deftroyed, which fuppofing to be the cafe, I have made my calculations with clover, grown for the purpofe; for inftance, I will take one acre of clover, which at one cutting will produce

produce from fourteen to eighteen tons of green vegetable matter, and about three tons of lime: this, when decompofed by the above procefs, will yield afhes fufficient to manure four acres, the value of which I eftimate at fomething under four pounds; the clover, according to the value of land here, I will fay two pounds, which, take the average of the kingdom, is too much. The lime I will alfo fay two pounds; but that will vary, according to the diftance it is to be fetched. Take them together, I think will be about the average value. Now if this is the cafe, and as far as I have been able to try it I find fo, how valuable muft it be to the community in general! If it anfwers the purpofe, I fhall feel myfelf much obliged by the Society making it as public as they poffibly can.

The vegetables fhould be ufed as foon after they are cut as poffible, and lime as frefh from the kiln as the diftance will allow of; as on thofe two circumftances depends the goodnefs of the compofition.

VI. *Agenda, or a Collection of Obfervations and Refearches the Refults of which may ferve as the Foundation for a Theory of the Earth. By* M. DE SAUSSURE. *From* Journal des Mines. *No. XX.*

WHEN about to contemplate objects fo complex as thofe that muft be ftudied to found on obfervation the bafis of a theory of the earth, it is indifpenfibly neceffary that we fhould previoufly form a regular plan; prefcribe for ourfelves a certain order; and minute down, if I may ufe the expreffion, the queftions which we wifh to propofe to nature. As the geologift commonly ftudies and obferves while travelling, the leaft diftraction may deprive him, perhaps for ever, of an interefting object. Even without interruption the objects of his ftudy are fo various and fo numerous, that fome of them may eafily efcape his notice. An obfervation which appears important by engaging his whole attention makes him often forget others: ſometimes he is diſcouraged by bad weather, or becomes abſent through fatigue; and the neglect produced by all theſe cauſes gives riſe to deep regret, and even frequently oblige him to turn back; whereas if he has a collection of memorandums on which he can from time to time caſt his eye, he will be reminded of all thoſe objects which ought to engage his attention. This collection, confined at firſt, will be extended and improved in proportion as he acquires ideas, and may furniſh hints to travellers who, without being verſed in geology, wiſh to collect, in the countries they viſit, obſervations that may be uſeful to thoſe who ſtudy that ſcience*.

Agreeably to theſe principles I have always prepared for all my journeys a liſt of thoſe objects, for examining which that journey was intended. I propoſe here, however, a more extenſive plan. I wiſh to direct the traveller, and even the ſedentary philoſopher, in all the reſearches which ought to engage their attention, if they are deſirous of contributing towards the progreſs of a theory of our globe. I do not flatter myſelf that I ſhall be able to give a complete view of every thing that remains to be done: what I offer will be only an imperfect ſketch, but this ſketch will be at leaſt uſeful till ſome one produce a better. Several of the obſervations and queſtions which I here propoſe as problematic, ſeem indeed to have been already reſolved; but as moſt ſolutions of this kind are founded merely on analogy, the contrary of which is always phyſically poſſible, it is proper, in my opinion, to keep the eyes of naturaliſts always open to the grand facts which may be intereſting to a theory ſo difficult and of ſo much importance.

* Voyage dans les Alpes, vol. i. Preliminary Diſcourſe.

CHAP.

CHAP. I.

Aſtronomical Principles.

1. A general ſyſtem of coſmology, in what regards the earth conſidered as a planet.

2. The figure and dimenſions of the earth determined.

3. The denſity of the earth determined by the deviation of a plummet near ſome mountains, the dimenſions and denſity of which are known.

4. Whether any principles or hypotheſes, depending on aſtronomical geography, can explain the great changes in the temperature of ſome parts of our globe?

5. The courſes of comets. Whether it be poſſible that they may have met with, or ſtill meet with, the earth in their orbits, and what are the effects of ſuch a meeting?

6. Whether it be poſſible, I do not ſay probable, that a comet, by paſſing through part of the ſun, may have detached from it the earth and the other planets?

7. Is it probable that the earth's rotary motion has been formerly more rapid than it is at preſent?

8. If the grand chains of mountains exiſted before the rotary motion of the earth, is it poſſible that that motion produced any change in their original ſituation *?

CHAP. II.

Chemical and Phyſical Principles.

1. The theory of attraction and chemical affinities; of ſolution, cryſtalliſation, and precipitation.

2. The theory of elaſtic fluids in general, and the cauſe of their elaſticity †.

3. The theory of caloric and light; of the origin and nature of the different gaſes, and of the atmoſphere. Electricity, and the aurora borealis.

* Tableau des Etats Unis. Note of M. A. Pictet, p. 125.

† Syſtem of M. Le Sage.

4. The

4. The theory of the calcination of metals, and of the decompofition of water.

5. Meafuring heights by the barometer.

6. How the temperature of climates is modified by the winds, evaporation, the nature and elevation of the ground.

7. Whether thefe caufes are fufficient to explain certain changes, fuch as that of the plants and animals of warmer countries having been able to exift and multiply in the coldeft countries?

8. Mineralogy, the nature of earths, ftones, falts, bituminous fubftances and metals. The principles of their analyfis and nomenclature.

9. If it be poffible to tranfmute one earth or one metal into another. For example, if it be poffible that filiceous earth can be changed into calcareous earth in the bodies of marine animals; or, reciprocally, that calcareous can be changed into filiceous earth in mountains of chalk?

10. If it be probable, according to the conjecture of Lavoifier, that earths are the oxyds of metals?

11. What idea can we form of one or more folvents which, either fimultaneoufly or fucceffively, may have rendered foluble in water the different mineral fubftances which we fee on the furface and in the bowels of the earth?

12. Can we believe that thefe folvents may have been afterwards deftroyed; and that it is in confequence of their deftruction that the matters they held in folution were precipitated and became cryftallifed?

12. A. Or, can we believe, with Dolomieu, that all cryftallifations may take place without previous folution; and that it is fufficient for this operation that the bodies be reduced to their elementary parts, and that thefe parts be fufpended in a fluid which gives them liberty to unite by their correfponding faces?

13. Can we fuppofe that the electric and magnetic fluids enter, as elements, into the compofition of bodies?

14. Does

14. Does it appear probable that the nitric, muriatic, and boracic acids, as well as the three alkalies, are of new formation; while the ſulphuric, phoſphoric, carbonic, tungſtic, molibdic, and arſenic acids exiſted before the formation of animals * ?

15. If we believe that the mineral alkali or ſoda was of ancient formation, may we not ſuppoſe that the ancient ocean held this alkali in ſolution? That would explain how it might have diſſolved ſiliceous earth and argil without being able to nouriſh animals. Afterwards, when the marine acid was formed, or had iſſued from ſome cavity, the ſea might have become proper for animals, and improper for the ſolution of ſiliceous earth and argil.

16. Is it probable that in the firſt ages of the exiſtence of our globe its atmoſphere was higher than at preſent; that its lower ſtrata were thus of a much greater denſity, and ſuſceptible of receiving from the ſun a greater heat?

17. May we preſume that the waters of the ancient ocean, before the formation of the primitive mountains, had a heat ſuperior to that of boiling water?

18. What temperature may we ſuppoſe at preſent to exiſt at the centre of the earth?

19. Is it poſſible that the quartzy earth found in petrified vegetables and animals has proceeded from the ſubſtance of theſe bodies?

CHAP. III.

Hiſtorical Monuments.

Though the grand revolutions of our globe have been anterior to all hiſtories and monuments of art, light may, however, be acquired from the traditions which hiſtory has preſerved †:

* Theorie de la Terre de M. de Lametherie.

† And alſo from the analogy between the languages and cuſtoms of different countries. C.

1. In regard to the ſituation of thoſe countries which were firſt inhabited.

2. In regard to the order in which they were ſucceſſively inhabited.

We ſhall thence ſee whether it be true, as ſome traditions aſſert, that this habitation was determined by the progreſſive retiring of the waters; and by coming to periods leſs remote and leſs involved in obſcurity, hiſtory may point out to us—

3. The changes undergone by the ſeas, lakes, rivers, and even ſome of the ſolid parts of the globe.

4. It will throw ſome light on the origin of the different races of men and animals; on the modifications they have experienced; and on the real or pretended loſs of ſome of theſe races.

5. The deluges or great inundations; their epochs and extent.

6. Whether there exiſt proofs of the diminution of the water of the ſea; and what may be the cauſe of it?

7. If it be probable that large caverns have been opened in the bowels of the earth, and that theſe caverns ſwallowed up a part of the waters?

8. Do there exiſt any hiſtorical monuments which prove that the countries at preſent cold were formerly ſo warm as to favour the multiplication of plants and animals which are no longer found but in the torrid zone?

CHAP. IV.

Obſervations to be made on the Seas.

1. Their form, extent and ſituation; thoſe of their great gulphs and ſtraits; their relative elevation.

2. The ſenſible flux and reflux out of the ocean, at the extremity of ſome gulphs and in ſome ſtraits; their periods and their limits.

3. Their bottom; notes of the places where they are deepeſt, and of the moſt remarkable ſhoals; their poſition and extent.

4. Currents

4. Currents at the ſurface or at different depths; their direction, velocity and limits; their relation to rivers, the winds, and form of the coaſts; the matters which they accumulate, and the places where they depoſit them.

5. Subterranean mountains and valleys; their relation with iſlands, and even with the terreſtrial mountains and valleys.

6. The nature of the mud, ſand and rocks, of which the bed of every ſea is compoſed.

7. An analyſis of the water of the different ſeas; and, at leaſt, their ſaltneſs at different depths and in different climates.

8. Their temperature at different depths and in different climates.

9. The fiſh and teſtaceous animals peculiar to different ſeas, depths and climates, which may ſerve to characteriſe them.

10. In what the preſent ſeas differ, in a phyſical and chemical view, from the great ocean, which, according to ſome ſyſtems, is ſuppoſed to have covered the whole ſurface of our globe?

11. Can we believe that there are ſtill formed ſtoney ſtrata at the bottom of the ſeas, and that their waters have conſequently that diſſolving power which is ſuppoſed to have belonged to the ancient ocean?

CHAP. V.

Obſervations to be made on the Borders of the Sea.

1. If the ſea coaſt is ſteep; if it forms ſteep hills, to obſerve their height, their nature, and the ſtrata of which they conſiſt *.

2. To ſeek on theſe hills traces of the effects or abode of the waters at different heights above the preſent level, and at different depths below, ſuch as furrows, caverns, ſhells,

* 1. A. To note down every thing that relates to the deſtruction, more or leſs rapid, of theſe hills, and the banks and accumulations formed chiefly at the mouths of rivers. C.

pholades; to fearch alfo for veftiges of the labours of man, fuch as excavations, rings for making faft veffels; in a word, to endeavour to afcertain whether the fea has the fame level as it had in the remoteft ages.

3. In cafe the level has changed, to examine whether that effect has been produced by a change in the fea itfelf, or whether the fhore rather has not been raifed or depreffed.

4. If the fea coaft is flat, to difcover to what diftance its acclivity is infenfible; and to examine the nature of the fand found on the fhore.

5. Whether the grains of that fand are round or angular, cryftallifed or not, quartzy or calcareous, or of any other kind of ftone.

6. To endeavour to difcover its origin, whether it can be confidered as produced by detrition from the neighbouring mountains or hills; whether it may not have proceeded from fome river which had its mouth in the neighbourhood, or whether it may not have been brought from the bottom of the fea itfelf by the tide and the waves?

7. Whether this fand contains, like that of Rimini, microfcopic fhells of the order of thofe called *pelagian?*

8. Whether there are not fhells on the borders of the fea; and, if there are, to determine thofe by which that coaft feems to be characterifed.

9. Whether there are any rolled pebbles?

10. To examine, as in No. 2, chiefly on the fhore, and even pretty far up the country, whether there are any proofs that the fea gains on the land, or the latter on the fea; and, in cafe the fea feems to recede, to difcover whether that may not be occafioned by the land rifing by accumulations wafhed down from the higher grounds; by fubterranean caufes, or reciprocally.

11. If a progreffive difplacing of the ocean really exifts, by what obfervations can the fyftems, which tend to explain it, be verified? Some have employed, for that purpofe, the currents produced by the trade winds; others, the fhock of the

the tides and currents; and others, a change in the earth's centre of gravity, occasioned either by deposits transported by rivers to the sea, or by the progressive movement of some mass detached from the interior parts of the earth supposed to be concave *.

[To be continued.]

VII. *Analysis of the Spinel Ruby. By* C. VAUQUELIN, *Inspector of Mines and Member of the French National Institute. From* Journal des Mines, *No. XXXVIII.*

IRON and manganese have long been considered as almost the only metals employed by nature to colour minerals; but though these metals may assume a multitude of different shades according to the proportions of oxygen which they contain, we however often see in nature bodies possessed of colours which neither iron nor manganese ever formed artificially or naturally when pure, and it is probable that we shall one day find many other colouring metals and also stones and earths.

I have already announced that the colour of the emerald, which all chemists ascribed to iron, is owing to the oxyd of chrome. In examining the peculiar red colour of the spinel ruby with the results of the analysis lately made of it by Professor Klaproth, I began to doubt of that rich and beautiful colour being produced by the oxyd of iron, of which the Professor found only 1·5 in 100 †. My doubts in this respect were still increased by reading in Bergmann that the ruby fused with borax communicates to it a beautiful green

* 12. To observe whether there are not daily formed different kinds of stones in the places which are washed by the waters of the sea. C.

† The number, nature and proportion of the principles found by Klaproth in the spinel ruby are stated as follows: Alumine 76; siliceous earth 16; magnesia 8; oxyd of iron 1·5:—Total 101·5.

colour,

colour, as well as by a paffage of Klaproth, in which he fays, that magnefia extracted from that precious ftone, being diffolved in the fulphuric acid, had given to it a green colour. The rubies of different colours preferved in collections, fuch as the fapphire-blue in the poffeffion of the Hon. Mr. Greville, the green belonging to Mr. Hawkins, and the white in the collection of Mr. Macie of London, authorifed me to fufpect that iron is not the colouring principle of that ftone.

Thefe different confiderations induced me to make a new analyfis of the fpinel ruby: and the refult of this labour will prove, that my doubts were not without foundation, and that it not only does not contain a fingle particle of the oxyd of iron, but that there is even no filiceous earth in it, as announced by Klaproth. The rubies employed for this analyfis were cryftallifed, tranfparent, and free from any foreign mixture.

Exp. I. A hundred parts of this ftone being expofed to a violent heat, loft nothing of their weight, but their tint was weakened and changed to a rofe colour.

II. A hundred parts of the fame ftone reduced to a fine powder, and ftrongly heated in a charcoal crucible, were agglutinated into one mafs of a greenifh grey colour.

III. A hundred parts of the fmall fragments of rubies reduced to an impalpable powder in a mortar of filex, were increafed five parts.

IV. I heated for an hour, in a filver crucible, 100 parts of a ruby thus pulverifed, with 300 parts of cauftic potafh: the mixture was not fufed; on the contrary it was reduced to a pulverulent mafs of a green colour, of which fome particles were merely agglutinated. I mixed this with diftilled water, in which it was all fo nearly diffolved that there remained of it only fome particles which weighed fcarcely three parts. I poured upon the folution, which remained ftill mixed with the undiffolved matter above-mentioned, fome diluted muriatic acid. The firft portions of this acid made the folution affume the appearance of a mafs as thick as foup (bouillie), which was re-

diffolved,

diffolved, at leaft for the greater part, by additional quantities of the acid. I warmed the folution by a gentle heat, and having filtered it, there remained on the paper three parts of a rofe-coloured powder, which was ruby, not decompofed. This I placed apart, that I might operate only on that portion which had been attacked.

V. The muriatic folution above mentioned having been evaporated to drynefs by a gentle heat, I poured upon the refiduum a large quantity of diftilled water: almoft the whole of it was diffolved. There remained only five parts of a grey powder, which melted with borax, to which it communicated a green colour.

VI. I fubjected thefe five parts to different tefts, which fhewed, that they were filiceous earth mixed with a little alumine, and coloured by a matter, of which I fhall fpeak hereafter*.

VII. I precipitated the muriatic folution of Exp. V. with carbonat of ammonia. When I judged that I had added a fufficient quantity, I boiled the mixture for a quarter of an hour, in order to expel the carbonic acid, and favour the precipitation of the lime or magnefia, if there were any of thefe in it. By thefe means I obtained an abundant white precipitate, which I boiled with a folution of cauftic potafh. The greater part of this precipitate was diffolved. There remained only $10\frac{1}{2}$ parts of a brown fubftance inclining to violet, but which turned to a yellowifh-green colour, by drying in a gentle heat.

* In another analyfis of the ruby I had for refiduum, after the evaporation of the muriatic folution, but five parts and a half of filiceous earth, flightly coloured green, and without any mixture of alumine. This difference arifes from the degree of heat given to the matter towards the end of the evaporation, or from the faline mafs not being equally ftirred throughout. In the latter cafe it happens that there are parts which dry too much, and others which do not dry fufficiently. Hence it happens that moleculæ of alumine are abandoned by the acid, while moleculæ of filex remain combined; and this was the cafe in my firft analyfis.

VIII. These $10\frac{1}{2}$ parts were dissolved by the sulphuric acid. The solution had a greenish colour. This solution mixed with the saturated carbonat of potash, precipitated a greenish matter, which, when washed and dried, weighed two parts. A small portion of this precipitate melted with borax communicated to it a beautiful emerald green colour*. This matter, which I placed apart, I shall speak of hereafter.

IX. As I had dissolved in the sulphuric acid 10·5 of matter, and as the carbonat of potash precipitated only 2, there must have remained 8·5 in the solution. Suspecting therefore that the matter was retained there by an excess of the carbonic acid, I boiled the liquor for some minutes, and I obtained a white granulated precipitate, weighing 16 parts, which by calcination were reduced to 8. This matter, combined with the sulphuric acid, gave a salt crystallised in tetraedral prisms, terminated by pyramids with four faces, the taste of which was first sweet, and afterwards bitter; which was not precipitated by the saturated carbonat of potash; was only partly so by ammonia; and, in a word, which presented all the characters of sulphat of magnesia. The ruby therefore, according to this experiment, should contain 8 parts of magnesia in 100; but as $\frac{1}{2}$ part was wanting in that subjected to experiment, we may estimate the quantity at 8·5.

* In heating the colouring matter of the ruby with borax over charcoal, and stopping the operation before the effervescence had ceased, I have twice obtained a vitreous globule of a red colour, perfectly similar to that of the ruby; but in heating again this red globule, the effervescence was renewed, and the globule became of an emerald green colour. In vain did I afterwards try to make the red colour re-appear, whether I applied the exterior or the interior flame of the blow-pipe. It is even very difficult to obtain, in the first instance, the vitreous globule of a red colour. It is necessary for that purpose that the colouring matter should not touch the charcoal; that it should not be added till the borax is melted; and that it should be heated with the exterior flame. Though I often attempted to produce this phenomenon, I never succeeded but twice.

X. I united the five parts of Ex. VI. and the two parts of Ex. IX; boiled them five or six times successively in a porcelain vessel with concentrated nitric acid, evaporating each time to dryness. The matter at first assumed a beautiful dark green colour, and at the end of each operation it boiled and was puffed up like alum. At last, when the greater part of the acid was evaporated, and the matter began to dry, it assumed an orange yellow colour. After treating the matter in this manner, I mixed with it a little pure caustic potash; and when the mixture was well formed and reduced to a kind of paste, I diluted it with distilled water, in which almost the whole of the matter was dissolved. Nothing remained but a little grey matter which weighed about $1\frac{1}{2}$ parts, and which I found to be siliceous earth. The alkaline solution had a weak golden yellow colour; and as it contained an excess of alkali, I added, in order that it might be saturated, a few drops of nitric acid. By this addition there was produced a slight white precipitate, which weighed at most one part, and which appeared to me to be alumine. The liquor had then a reddish colour.

XI. As I suspected, from all the phenomena which had appeared during the course of this analysis, that the colouring matter of the ruby was chrome, I mixed the liquor of the preceding experiment, first, with nitrat of lead, and I immediately obtained a precipitate of a beautiful orange-yellow colour; second, with nitrat of mercury, and there was produced a deposit of a cinnabar red colour; and, third, with the nitrat of silver, which gave a precipitate of a crimson red colour. I was convinced by these phenomena that the ruby, like the emerald of Peru, contains a certain quantity of chrome, to which it is indebted for its colour. But it seems difficult at first to reconcile the colour of the emerald with that of the ruby, by referring them to the same substance; for nothing seems more remote from green than red. If we however recollect that this metal is susceptible

of

of assuming different colours according to the quantities of oxygen which it absorbs; that when it is saturated with this principle, it is red and acid; and when it contains less, it is green, and in the state of an oxyd, we shall readily conceive how this oxydated metal may colour the emerald and the ruby. It follows then from these considerations, that chrome exists in the emerald in the state of an oxyd, and in the ruby in the state of an acid; and that this acid is there, doubtless, in a saline combination with alumine or magnesia, and perhaps with both at the same time. With regard to the proportion of the chromic acid in the ruby, I have not been able to determine it very accurately, on account of the affinity which it has with alumine, from which it is difficult to separate it completely. I am however of opinion that it may be estimated, without committing any very sensible error, at between 5 and 6 parts in 100 of ruby.

XII. I now return to the solution of alumine in caustic potash (Exp. VII.). I super-saturated it with the muriatic acid, and precipitated it afterwards by the carbonat of ammonia. The deposit washed and kept at a red heat for a considerable time weighed 85 parts. This matter had all the properties of alumine. As I had however scarcely found any siliceous earth during the course of this analysis, and as Klaproth says that he obtained 16 in 100 parts of this stone, I wished to assure myself whether there might not be some of it remaining in the alumine. For that purpose I dissolved the 82 parts above-mentioned in the sulphuric acid, and I indeed obtained an insoluble residuum which weighed three parts, and which was siliceous earth. This, with the $1\frac{1}{2}$ part obtained (Exp. X.), makes $4\frac{1}{2}$ parts. But it must be recollected, that during the pulverisation of the 100 parts of ruby, the details of the analysis of which I have explained, 5 parts were taken from the mortar of silex; from which it follows, that the $4\frac{1}{2}$ parts of this substance found in the course of these operations did not belong to the ruby. Whatever method

method I employed, and whatever care I took, I could never obtain a larger quantity, and therefore it is very probable that Klaproth was deceived in this respect.

Now, to establish the proportions of the principles of the ruby, I must here observe, that of 100 parts subjected to analysis, 97 only were attacked; but 97 having furnished 85 of alumine (Exp. XII.), 3 of which were to be taken away for the siliceous earth, 100 would have given 82·47; 8·5 of magnesia having been obtained from these 97, 8·78 would have been found in 100. In the like manner, instead of 6 of the chromic acid, we should have had 6·18. Thus, 100 parts of spinel ruby consist of alumine 82·47, magnesia 8·78, chromic acid 6·18. Loss 2·57. Total 100.

XIII. To prove the correctness of the results of the preceding analysis, I repeated it by following another method. I heated 100 parts of ruby, reduced to a fine powder, for several hours with concentrated sulphuric acid. I obtained a solution, almost complete, by the addition of a sufficient quantity of water. There remained nothing but 5 or 6 parts of a grey powder, which had all the characters of siliceous earth, and which was only mixed with a little chrome.

The solution evaporated to the consistence of syrup gave radiated crystals without solidity; but these crystals, re-dissolved in water, and the solution mixed with a sufficient quantity of the sulphat of potash, gave octaedral crystals of alum. The whole 100 parts of the ruby thus dissolved in the sulphuric acid furnished me, in several successive crystallisations, with about 800 parts * of alum, without reckoning the latter portions which I could not entirely separate from the mother water. This mother water had a green colour, and a bitter slightly metallic taste. I diluted it with water, and mixed with it a solution of the carbonat of potash. There was formed a greenish white precipitate, which was a mixture of alumine and the oxyd of chrome. The liquor filtered

* The same article in the Annales de Chemie, Messidor An. VI. states this product at 775. EDIT.

and

and expoſed to heat depoſited a white powder, which, waſhed and dried, weighed 17 parts, that were reduced to 8·3 by calcination. They conſiſted of magneſia, ſtill mixed with a few particles of oxyd. The precipitate formed in the mother water by the carbonat of potaſh was treated with a ſolution of cauſtic potaſh. By theſe means the alumine was diſſolved, and the oxyd of chrome remained without undergoing any ſenſible alteration: it weighed 5 parts.

This analyſis perfectly confirms the former; for, ſome ſlight differences in the proportions excepted, it abſolutely gave the ſame reſults. It proves above all that the ruby does not contain ſiliceous earth, and that the ſmall quantity found in the products was furniſhed by the mortar in which the ſtone was pounded.

I muſt here obſerve, that it does not always happen that the whole maſs of the ruby is diſſolved during the firſt operation. There remains ſometimes ſeveral parts which have undergone no alteration. This depends on the time employed for ebullition, and ſtill more on the degree of fineneſs to which the ſtone is reduced before it is ſubjected to trial. But when that happens, after having waſhed the reſiduum, which is inſoluble in the acid, it muſt be dried, pounded again, and treated in the ſame manner as before. Nothing then ought abſolutely to remain but the ſiliceous earth belonging to the mortar.

XIV. The muriatic acid diſſolves the ruby alſo: but a conſiderable portion of it is required; becauſe it volatiliſes in a moderate heat, and without a ſtrong degree of heat it makes no ſenſible impreſſion on that ſubſtance. I obſerved that this acid diſſolves the principles of the ruby in the ſame proportions as they hold between themſelves in the ſtone; for the portion not attacked abſolutely preſerves the ſame ſhade of colour as that which it had before ſubjected to the action of the acid. This proves that it does not diſſolve one principle in preference to another, and that they are in a ſtate of real combination in the ruby.

From thefe confiderations it would appear natural to confider the ruby as a faline fubftance, compofed of two bafes, alumine and magnefia, and of an acid called the chromic acid.

When I announced to the National Inftitute that I had not found magnefia in the ruby, I was however far from imagining that Klaproth was deceived; fo much confidence did I place in the labours of that able chemift. I chofe rather to conclude at that time, that the ruby I had examined was different from his. But I was in an error in that refpect, as I was convinced by a new analyfis, which I made of about 16 grammes of the fame ruby; and it was from this latter labour, carried on in a manner fomewhat different, that I eftablifhed the proportions of the principles of this ftone, as already enumerated. This proves the neceffity of employing rather large maffes, in order to find fmall quantities of matter. I thought it my duty to make this public acknowledgement, both that I might render juftice to accuracy and to the fagacity of a man who has given fo many proofs of it, and to avoid the reproach which might have been thrown out againft me, of wifhing to conceal an error into which I had fallen.

VIII. *Defcription of a remarkable Spring of Frefh Water, which rifes through the Water of the Sea. By the Abbé* Spallanzani. *From the* Journal de Phyfique, *Vol. XXIX.*

THIS fpring rifes through the falt water at the diftance of fixty-five feet from the fhore and about a mile from Spezzia. It raifes itfelf fome inches above the furface of the fea, and forms a fort of accumulation, fhaped like a button of about twenty feet in diameter. This button, when the fea is perfectly calm, is full of watery radii, exceedingly perceptible. The water of which they are formed feems a little turbid; and this is very apparent, efpecially when it has rained: the ſurrounding water is on the other hand perfectly tranſparent. Theſe radii will not ſuffer a boat to remain ſteady on the centre of the button, but, as may be readily ſuppoſed, throw it back to the circumference. M. Spallanzani, however, found means to fix himſelf in that poſition, and was thence enabled to examine carefully the water at the bottom, as well as that at the ſurface.

The water at the ſurface is not freſh, but a little leſs ſalt than that by which it is ſurrounded. The depth of the ſpring is 38½ feet. When the heaving-lead approaches the bottom, it is obſerved that the ſmall line to which it is made faſt begins to tremble; and as this trembling is obſerved no where elſe, it is plain that it is occaſioned by the violent impulſe of the water of the ſpring againſt the bottom of the lead. The water being leſs ſalt at the ſurface than the ſea-water, with which it has mixed itſelf, it is natural to ſuppoſe that it is perfectly freſh at the bottom. To aſcertain this, M. Spallanzani invented a machine, by which he could draw up ſome of it from the bottom, in ſuch a manner as not to be mixed with the ſalt water by the way; and the water procured in this manner, though exceedingly turbid and ſlimy, was found to be perfectly freſh. He remarked alſo, that this water, when compared with the ſea-water, was remarkably cool, which aroſe probably from its riſing from ſome depth under the earth. The braſs machine alſo was once very much beat together, which could be occaſioned by nothing elſe than the violence with which the water iſſued from the ground, and by which the machine had probably been daſhed againſt a ſtone.

M. Spallanzani is of opinion that the origin of this ſpring is as follows:—There are two ſmall ſtreams which flow from the ſide of a hill at the diſtance of three miles from Spezzia. Theſe ſtreams are afterwards united, and throw themſelves into an unfathomable abyſs, from which the water, as it is ſufficiently ſecured from the ſummer heat, forces its way through the earth, and ſupplies ſufficient nouriſhment to the fountain that ſprings up through the ſalt water.

IX. *Experiments respecting the Effects of Electricity on the Fermentation of Vegetable and the Corruption of Dead Animal Substances.* By M. ACHARD. *From* Memoires de l'Academie de Berlin.

IT is a well-known obfervation, that, after a ftorm, flefh, either raw or boiled, acquires a putrid fmell, which in the latter is particularly acid. It is known alfo, that grain fuffered to ferment for the purpofes of brewing or diftilling, undergoes, during ftormy weather, very fudden and perceptible changes. On fuch occafions it is often extremely difficult to obferve where the firft degree of fermentation ceafes, as it paffes fo fpeedily, and the fecond degree or the acetous fermentation takes place before one is aware. To afcertain, therefore, whether the electric matter, which during ftormy weather is fo abundant in the atmofphere, has any fhare in thefe phenomena, M. Achard made the following experiments.

He cut a piece of raw beef into three parts, and electrified the firft pofitively for ten hours without any fhock; the fecond he electrified for as long negatively, and the third he did not electrify. Thefe three pieces were left in the fame apartment, and expofed to the fame degree of heat. When examined next day, both the pieces which had been electrified appeared to be tender, but were free from the leaft bad fmell. On the fourth day the electrified flefh had an intolerably fetid fmell, and that which had not been electrified began to fmell a little.

M. Achard repeated thefe experiments with boiled veal. That which was electrified had the next day an acid fmell and an unpleafant tafte; but that which had not been electrified continued fweet for three days, and only on the fourth day began to have an acid fmell.

M. Achard then killed feveral birds by electric fhocks, and at the fame time deprived others of life by fticking a needle through their heads, and, placing them all in the fame temperature, covered them with glafs receivers in order to preferve them from infects. Having obferved the gradual progrefs of corruption in both, he plainly perceived that it took place much fooner, and advanced more rapidly in thofe killed by electric fhocks than in thofe deprived of life by the needle. In thofe alfo to which a ftronger fhock had been given, the degree of corruption was far ftronger than in the others; and the caufe in all probability was, that in this cafe the veffels containing the animal fluids were fuddenly deftroyed, by which means thefe fluids had diffufed themfelves through the particles of the body, and might thus accelerate putridity.

It clearly follows from thefe experiments, that electricity accelerates corruption, and that the putrefaction of flefh after a ftorm muft be afcribed folely to the more abundant accumulation of the electric matter at that time. M. Achard faw that this was the cafe in regard to feveral perfons killed by lightning. The body of a farmer, who loft his life in this manner on the 2d of July, between five and fix o'clock in the evening, emitted next morning a very perceptible fetid fmell, which in the evening was totally infupportable.

M. Achard took a handful of rye, which had been brought to a ftate of fermentation in order to be diftilled, and divided it into two portions, one of which he electrified. Five hours after being electrified, the vinous fermentation was over in the firft portion; but this was not the cafe in regard to that which had not been electrified, till after eight hours. M. Achard repeated this experiment in fuch a manner that he fent a number of ftrong fparks through a portion of rye, inftead of giving it an electric bath, and always found, except in one cafe, that fermentation was accelerated by the electricity. The cafe in which a contrary effect was produced, may have been occafioned by fome circumftance which efcaped M. Achard's attention.

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On this occaſion M. Achard made two experiments alſo, in order to aſcertain what effect would be produced on air when electrified without ſparks. The object of his firſt experiment was in particular to diſcover whether the atmoſphere, by being electrified, would become oxygenated, or retain its goodneſs; and that of the ſecond, to determine whether a certain volume of air would be enlarged when electrified poſitively, or be diminiſhed when electrified negatively.

For this purpoſe he took a Leyden flaſk filled with air, the degree of the oxygenation of which he had previouſly aſcertained by an eudiometer, and electrified it as ſtrongly as poſſible: he then let it ſtand a few hours, and examined the air again; he, however, found neither abſorption nor dilatation to have taken place: and the caſe was the ſame when he expoſed the jar to abundance of ſparks; from which it appears, that the quality of the air is not changed by electricity.

He then electrified a jar cloſely ſtopped, through the cover of which a bent glaſs tube proceeded downwards parallel to the ſide of the jar, and the exterior part of the tube was placed in a ſmall veſſel filled with water. He charged this jar poſitively and negatively. Had the poſitive electricity occupied that ſpace which the air before occupied, the water muſt have ſunk in the tube; and had this ſpace been leſſened by the negative electricity, the water muſt have riſen in the tube. As neither of theſe was the caſe, the electric matter muſt paſs through the interſtices of the air without cauſing a farther ſeparation of its component parts; and that matter alſo which goes out in electrifying negatively, muſt be contained merely in the interſtices, without occaſioning any alteration in the particles of the air.

X. *Obſervations and Experiments on Staining Wood. By Profeſſor* BECKMANN. *From* New Tranſactions of the Royal Society of Göttingen, *Vol. VI.*

THE oldeſt inlaid works now extant are preſerved in Italy, and the moſt highly eſteemed of theſe are thoſe made by John of Verona, a monk and cotemporary of Raphael, who was born in 1470, and died in 1537. He was invited to Rome by Pope Julius II. in order that he might add to the ſplendour and magnificence of the Vatican; and he left behind him many ſpecimens of his art at Sienna, Naples, and other Italian cities. The works of this artiſt, on account of the variety and beauty of the ſtained pieces of wood employed in them, are ſtill celebrated among connoiſſeurs, and preferred to all new works of the like kind. It is, however, to be lamented, that the proceſſes uſed by John of Verona are at preſent altogether unknown, though the wood he employed was chiefly of European growth. Veneered or inlaid works are now ſo much in vogue, that there are few houſes in which ſome of the furniture is not ornamented in this manner; and the ſums of money expended every year for different kinds of foreign wood, neceſſary to ſupply this luxury, is very conſiderable. Theſe woods are imported chiefly from India by the Engliſh, Dutch and French; and ſome of them are of more value than the beſt copper, the filings of which might be employed to make imitations of them. That narrow diſtrict alone on the Rhine between Darmſtadt and Heidelberg receives annually for wallnut-tree wood the ſum of 10,000 florins. Since mahogany furniture however began to be uſed, our cabinet-makers have made ſcarcely any thing elſe than common works, becauſe we are accuſtomed to purchaſe from the Engliſh, not only the materials, but alſo the works themſelves; ſo that the time may come when no workmen of this kind will be found in Germany: on that account, it is well worth the trouble to make

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experiments on the ſtaining of our own wood, in order to render them equal, if not to all foreign woods, at leaſt to ſome of them, ſince many things can be coloured in that manner which are harder and more compact than wood. The labours of Du Fay in this reſpect are well known; and it appears by ſome papers of his among the Memoirs of the Academy of Sciences, that rock cryſtal, when expoſed to the vapour of arſenic and antimony, aſſumes a red colour. Count de Borch's deſcription of the method of ſtaining marble in Italy may alſo be mentioned; and the proceſs by means of the ſmoke of oak chips, which is employed by the Dutch for colouring their tiles and earthen-ware. Canes are prepared for uſe in India, by dipping them in quicklime. That hard compact wood brought from America, and particularly Guiana, which, on account of its variegated and ſpotted appearance, is called *Bois de Lettres*, and which Aublet, who gives it the name of *Piratinera Guianenſis*, much admired, has its whole ſurface ſtained by the Indians with the blackeſt and moſt durable colours.—As the art of ſtaining wood ſeems at preſent to be nearly loſt, the following experiments may be of ſome utility to artiſts:

1. *By Means of Oils and Acids.*

Exp. I. A ſquare piece of plane-tree wood, a line in thickneſs, was put into pounded dragon's blood from the Canaries * mixed with oil of turpentine, and placed over the fire in a glaſs veſſel. The wood ſlowly aſſumed the colour, even before the ſpirit was volatiliſed. After more than an hour the veſſel was taken from the fire and ſuffered to ſtand the whole night, when the wood appeared of a mahogany colour, not merely on the ſurface, but alſo in the interior parts. The denſer fibres were ſomewhat leſs coloured, but this, inſtead of injuring the beauty of the wood, rather added to it. The red dye can be made ſtronger or weaker by taking a greater or leſs quantity of dragon's blood, and by a greater

* That from Madagaſcar is of an inferior quality.

or lefs degree of digeftion and boiling. The wood of the plane-tree was chofen for this purpofe, becaufe it can be eafily fawn and polifhed; becaufe it has a white colour; is neither too hard nor too foft; becaufe it neither contracts nor warps; has beautiful white fpots with veins that crofs each other; and becaufe artifts who make inlaid work have long attempted to colour it by ftaining. The wood, when ftained, can very eafily be freed from the dragon's blood adhering to it, by means of rectified fpirit of wine. The fpirit of turpentine makes the wood more compact, and renders it more fufceptible of a fine polifh.

II. Gamboge, diffolved in fpirit of turpentine, gave to the whole furface of a fmall piece of wood a moft beautiful fhining golden yellow colour. The fibres and veins, on the other hand, had affumed a colour inclining a little to red. A piece of the wood of the pear-tree affumed a darker colour, fomewhat approaching to green, and which in part was nearly an olive colour. Different colours may therefore be obtained by employing different kinds of wood.

III. One part of dragon's blood, two parts of gamboge, with fpirit of turpentine, gave to the wood of the plane-tree or beech, according to the mixture of the colours and the nature of the wood, a remarkable variation of dyes. A bit of beech wood feemed always to affume a blackifh yellow colour; and was thoroughly ftained, when moderate heat was kept up for a fufficient length of time.

IV. Diftilled verdigris (cryftallifed acetite of copper) could not eafily be ufed in the above manner, as its colour is too much changed by oil and fire, as is known to thofe who employ it as a pigment. The olive colour alfo does not penetrate to the interior part of the wood.

2. *By Means of Spirit of Wine.*

Exp. I. When dragon's blood and gamboge were merely diffolved in fpirit of wine, the extract was not fufficiently ftrong, and the dye was of no ufe. The procefs, however,

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ſucceeds when the ſpirit of wine has been long boiled over a ſlow fire till it is almoſt evaporated. The piece of wood appears then of a dark red colour, which is improved if the wood be waſhed in pure ſpirit of wine. But the colour is never ſo bright as that produced by means of an oil.

II. Gamboge with ſpirit of wine gave to wood in this manner a yellow, and gamboge and dragon's blood a yellowiſh red, colour.

3. *Experiment with Wax.*

White wood boiled in ſpirit of wine, to which, when it began to boil, wax was added, could not be made to aſſume the green or the red dye, even in its ſmall croſs veins, which were exceedingly porous.

4. *Experiments with diſſolved Salts and Metals.*

The following experiments with theſe ſubſtances, which have already been deſcribed by Macquer, ſeemed to be moſt ſucceſsful.

Exp. I. A ſolution of common alum (ſulphat of alumine) penetrates exceedingly well into wood which has been digeſted in it; ſo that hopes may be entertained of ſome thing being effected by it, as the white colour of every kind of wood becomes whiter by ſolutions of ſaline ſubſtances: this may be of great uſe to artiſts.

II. Wood ſoaked in a ſolution of gold aſſumed a red colour, but the inner part was only of a yellowiſh red.

III. Diſtilled verdigris diſſolved in vinegar ſtained wood green, but the colour could never be brought to a graſs green.

IV. Wood which has lain a long time under water becomes black, as experience ſhews, and looks as if charred. It, however, loſes none of its toughneſs or compactneſs; and many trees dug up in Holland from the turf earth are employed there for ſhip-building. This effect of the ſulphuric acid on wood gave occaſion to the following experiment.

Pieces

Pieces of different kinds of wood, of confiderable thicknefs, were placed in the fulphurous acid. In half an hour the whole furface of them was covered with a yellowifh fcurf, and the wood itfelf had the appearance of being charred. When wafhed in water, and expofed fome hours to the open air, it was obferved that the black colour had penetrated ftill farther, that the interior part only retained the natural colour, and that the wood was exceedingly clofe and compact. After this wood had been feveral times rubbed over with the oil or fpirit of turpentine, it became harder and firmer; fo that it could receive the higheft polifh; by which means the colour was rendered more agreeable. This procefs may be readily employed by artifts, as it is eafy, and does not require much expence.

V. Another black dye for ftaining wood, which fucceeds extremely well, and may lead to other ufeful experiments, is that formed with liver of fulphur (fulphuret of potafh) and metallic folutions. As the fulphurized hydrogen gas is fo fubtle that it penetrates the clofeft bodies, it might readily be conjectured that it would eafily give a black colour to wood, if the latter could any how be made to imbibe it with a metallic folution. Pieces of different kinds of wood were placed, for feveral days fucceffively, in a folution of acetite of lead, and a folution of filver, copper, iron, and other metals; after which a folution of arfenical liver of fulphur was prepared in the following manner: One part of the arfenical liver of fulphur was mixed with two parts of clear quick-lime, in a porcelain veffel, over which was poured fix or eight parts of boiling water. The folution was then poured off, and the wood which had been impregnated with the above metallic folutions being placed in it and fuffered to remain feveral days, the veffel being clofely fhut, it affumed a black colour. The folution of acetite of lead produced the greateft effect; that of filver next, and thofe of the other metals leaft of all. Spotted wood, and particularly that of the plane, beech and pear-tree, affumed the beft colour.

It

It is therefore beyond all doubt that porous wood, ſuch as that of the lime, the elder, &c. could be ſtained much eaſier. Though the arſenical liver of ſulphur from lime may appear ſuperfluous, as the common, which is prepared from alkaline ſalts and ſulphur, can produce the ſame effect, the above proceſs however is that which ought to be recommended. This method of ſtaining may be conſidered as the beſt, becauſe it impregnates the wood with metallic particles, gives it a hardneſs ſuſceptible of a fine poliſh, and ſecures it from worms. The veſſel employed for this purpoſe muſt be either of porcelain, ſtone ware, or glaſs.

XI. *Deſcription of a new Diving Machine, proper for being employed in Rivers, &c. By* C. H. Klingert. *Extracted from the* Author's Account of it, publiſhed at Breſlau.

FOR ſeveral centuries mankind have employed their ingenuity to deviſe means by which they might deſcend into the water, without danger, in order to ſearch for ſunk bodies; but all the inventions hitherto made for this purpoſe have never fully anſwered the propoſed end, as they have all been attended with inconveniences. Of theſe inventions the beſt known is the diving-bell; but if a man deſcends in ſuch a machine to a certain depth under water, the air being condenſed in the bell in proportion as the height of the column of water of equal diameter becomes greater, he can breathe only for a ſhort time; and the very nature of the machine prevents him from moving about at pleaſure, which is an object of the utmoſt impor[illegible] A deſire to obviate theſe difficulties induced the [illegible] contrive a machine in which a man could not o[illegible] deſcend at pleaſure, but even at the depth of fro[illegible] feet and more under water, walk, breathe, and m[illegible] and he was ſo far ſucceſsful that an experiment [illegible] his machine in the river Oder, in the presence of a great many spectators, exceeded what could have been expected.

It is well known, that the pressure of water increases with its depth; and as water is a dense body, a man cannot descend far in it without experiencing a very strong pressure: so that if a diver, whose head is five feet below the surface, attempts to breathe through a pipe, he finds himself incapable of inhaling the air, on account of the pressure he sustains on his breast. A man, therefore, to descend to a great depth, must have his body and breast free from the external pressure of the fluid. In order to secure him from this inconvenience, the author has invented a sort of harness, made of strong tin plate, in the form of a cylinder, which goes over the diver's head, and which consists of two parts, that he may conveniently thrust his arms through it and put it on; also a jacket with short sleeves, and drawers of strong leather. All these being water-tight, and closely joined round the body of the diver, secure every part of him but the arms and legs from the pressure of the water, which at the depth of 20 feet will occasion no inconvenience to these parts.

Fig. 1 (*Plate* 1) represents the diver covered with the harness, jacket and drawers.

Fig. 2 is the upper part of the cylinder, the diameter of which is equal to the breadth of a man at the top of the hip-bone. It is 15 inches in height, has a globular top, and is made of the strongest tin-plate.

In the inside of the cylinder, at *a*, is a strong broad iron hoop, to enable it to withstand better the pressure of the water; and in the inside of the top there are two pieces of a strong hoop of the same kind, placed over each other in the form of a cross at *b*. A strong ring of brass wire is soldered upon the outside at *c*, that the jacket may be fastened to it with an elastic bandage to prevent it from slipping downwards. At *d d* are the upper halves of the apertures for the arms; and *e e* are holes to afford light, and into which the eye glasses are screwed; *f* is the opening into

into which the mouth-piece of the breathing pipe is fcrewed; and *g* is an aperture for looking through, as well as for the purpofe of breathing when out of the water, and which, by means of the cover *h* fufpended from it, can be fcrewed up before the diver enters the water.

Fig. 3 reprefents the under part of the cylinder, which is alfo 15 inches in height, and which at *i* and *k* is ftrengthened by iron hoops on the infide, in the fame manner as the former. To the lower hoop *k* are foldered four fmall rings, to which are faftened ftrong leather ftraps, three inches in breadth, that can be buckled crofs-wife over the fhoulders, and fupport the whole machine; *l l* are the under halves of the apertures for the arms; *m* is alfo a ring of brafs wire foldered to the cylinder, which ferves to keep faft the jacket when buckled on, and to fupport the upper cylinder (*fig.* 2) which flips over the under one, and on that account the under one is a little fmaller fo as to fit into the upper one. There is alfo another fuch ring at *n*, in order to prevent the drawers from falling down.

At *o* (*fig.* 2, and *fig.* 6) is a ftrong femicircular piece of iron, the ufe of which is to prevent the drawers, when preffed by the water, from touching the under part of the body, otherwife the preffure, even at the depth of fix feet, would be infupportable. As it is not poffible to few the leather fo clofely as to prevent water from forcing its way through the feams, a fmall pump is fufpended at *p*, for the purpofe of pumping out the water when it has rifen to the height of a few inches in the lower cylinder. Four hooks *q q q q* foldered to the lower part of the cylinder are for the purpofe of fufpending weights from them.

The jacket *r* (*fig.* 1) with fhort fleeves that cover the upper part of the arms, ferves to prevent the water from penetrating through the joining of the cylinders, where the one is inferted into the other, as alfo through the holes for the arms, as it is bound faft round both parts of the cylinder

and

and likewise round the arms. The case is the same with the drawers, which are bound close round the knees.

Fig. 4 represents a brass elastic bandage, employed for fastening on the jacket, and which, when hooked together, is screwed fast by means of the screw *f*, three inches in length. A brass bandage is here used, because leather is apt to stretch, and on that account might be dangerous.

Fig. 5 is the mouth-piece to which the pipes *x y* are fastened, and which is screwed on at *f* (*fig.* 2); *t* is the screw; *u* the part that goes into the machine, and which is taken into the mouth; *v* the exterior part of it, in which there is a partition *w* in order to separate the pipes; and *z* is an aperture, that the air in the machine may communicate with the pipe *y*.

The internal diameter of these tubes is three fourths of an inch Rhinlandish. They consist of strong brass wire $1\frac{1}{2}$ line in thickness, wound into a spiral form, and covered with strong leather. In order to save expence, six yards of the pipe, from the mouth-piece, may be made in this manner, and the rest of tubes of tin-plate three or four yards in length, joined together with pieces of leather-pipe about a foot in length, prepared in the first manner.

The reservoir *a* (*fig.* 1), applied in such a manner that it can be screwed off, is for the purpose of collecting the small quantity of water that might force itself into the breathing pipe when long used, and which otherwise would be in continual motion and render breathing disagreeable.

To prevent the leather from becoming hard, and to close up its pores, so that it may be rendered water-tight, the following mixture was rubbed over it: viz. 6 parts of wax, 2 of Venetian turpentine, 2 of pitch, and 2 of melted hogs-lard. It is also to be observed, that the best and strongest leather must be used for the tubes, and that stripes of leather must be sewed very closely on the seams of the jacket and drawers.

If

If the machine be intended for diving to a great depth, it muſt be conſtructed in as ſtrong a manner as poſſible, and the drawers muſt be furniſhed with iron ribs in the inſide faſtened by means of hoops to the machine, as may be ſeen fig. 3 and 6, over which a net of ſmall chains or ſtrong cords muſt be hooked or tied to the hoop *k*, and alſo to the hoops 2, 2, 2, 2, by means of the holes made in them for that purpoſe; but theſe chains or cords in particular which go behind muſt not be drawn too tight, that the diver may be able to bend his body.

The ribs 1, 1, are ſcrewed on the inſide to the ſtrong iron hoop *k*, but in ſuch a manner as to be moveable; and as the centres reſt on the hips, the diver can move his legs backwards and forwards. To theſe ribs the two hoops 2, 2, are made faſt by riveting at 3, 3, and the two interior ribs 4, 5—4, 5 are faſtened in the like manner. To the latter muſt be ſoldered at 5, 5, a circular piece 6, 6, 6, of the like radius as the part *o*, which, as the diver walks, moves backwards and forwards on *o* by means of a groove, at the ſame time that the outer ribs move; and on account of theſe ribs, hoops, &c. the preſſure of the water upwards will preſent the leſs impediment to the diver, as it can act only according to the diameter of the ſmalleſt hoops 3, 4—3, 4.

The author gives the following inſtructions for uſing a machine of this kind. When the diver, after being made acquainted with all the parts of the machine, has put it on and ſuſpended from it the proper weights, let him enter the water at any convenient place, and advance till it reaches to his eyes, while the end of the pipe is held by a perſon on the bank. If the diver can then breathe with eaſe, and if no water forces itſelf into the pipe, which muſt be left to float on the water, he may proceed till it covers his head, having firſt taken the precaution to tie a ſtrong rope to one of his arms. After this he may ſtop for ſome time, and then gradually go deeper and deeper, making ſignals that he finds himſelf at eaſe, by pulling the rope, or by ſpeaking through the pipe. If a man exercifes himfelf in this manner for feveral days fucceffively, ftill increafing his depth, he will foon be able to dive boldly, and to move under the water with eafe and freedom: when he wifhes to afcend, he needs only unhook the weight, which will drop to the bottom; and being then lighter than an equal volume of water, he will rife to the furface. To preferve the weight from being loft, a particular rope muft be employed, which may be let down to the diver upon his making a certain fignal, and which he may faften to the weight before he unhooks it.

By following thefe directions a refolute man may be taught, in the courfe of a few days, to dive to a moderate depth, though on account of various preparations and unforefeen difficulties, the author employed five whole weeks in teaching one who was unacquainted with fwimming. This man, called Frederick William Joachim, a huntfman by profeffion, dived in the above apparatus into the Oder, near Breflau, where the water was of confiderable depth and the current ftrong, on the 24th of June 1797, before a great number of fpectators, and fawed through the trunk of a tree which was lying at the bottom. He fhewed alfo that he could have faftened funk bodies to a rope in order to be drawn up, and that in cafe any impediments fhould prevent the ufe of the faw, fuch trunks might be hewn to pieces by an axe. It clearly appears, therefore, that two men furnifhed with fuch apparatus could faw to pieces large beams of wood lying at the bottom of rivers, which are often a great obftruction, and, on account of their fize, cannot be otherwife removed.

One part of the conftruction was attended with an inconvenience, which it may be proper to mention. It has been already remarked, that a man at the depth of five feet under the water cannot breathe without a machine; and though one, fuch as that above defcribed, will defend his breaft and body from the preffure of the water, yet though it be furnifhed with a pipe to breathe through, it will appear, from what follows, that this will be impoſſible. The air which ſurrounds the diver in this machine amounts to ſomewhat more than a cubic foot. Now if he inhales air through the pipe ſcrewed to the machine, his body muſt diſtend a ſpace equal to the volume of air inhaled, conſequently he compreſſes ſo much the air that ſurrounds him in the machine. But as this is impoſſible, on account of its too great reſiſtance, he does not obtain air ſufficient to ſupport life, and is almoſt in the ſame ſtate as if ſurrounded by water. To be convinced of the truth of this, let any one take a caſk, equal in content to one or two cubic feet; preſs his mouth againſt the aperture of it, and try whether he can without difficulty breathe back into it the air he has inhaled. A larger ſpace around the diver in the machine would make breathing eaſier, but would not render him ſufficiently eaſy to labour. The interior air in the machine, therefore, muſt be connected with the pipe deſtined for breathing, in order that it may be at freedom to dilate as his body is extended; and it is only by a conſtruction of this kind, as ſhewn at *z* in deſcribing fig. 5, that a man can breathe while incloſed in ſo ſmall a ſpace. The author, at firſt, had furniſhed his mouth-piece with a valve, that the air might be again exhaled through it; but this valve was ſo ill conſtructed that it conveyed the exhaled air into the pipe deſtined for breathing. As he found that this was attended with inconvenience, on account of the moiſture which adhered to it, he afterwards omitted the valve entirely.

The diver, therefore, muſt ſuffer the air inhaled through the mouth-piece *u* to eſcape through his noſtrils into the machine; and then the air in it will remain equally elaſtic. The next time he draws breath, the air in the machine will be forced out from it at *z* by the diſtention of his body. By theſe means he will be able to breathe freely and eaſily for a long time; and thus the chief difficulty is overcome.

We cannot better conclude our account of M. Klingert's

 diving

diving machine than by recommending it to the attention of that benevolent inſtitution which has been the mean, in the hand of Providence, of averting the tear of ſorrow from the eye, and inexpreſſible anguiſh from the heart, of many individuals who daily implore that the richeſt bleſſings of Heaven may be ſhowered down upon the HUMANE SOCIETY. The apparatus ſeems ſo well contrived in all its parts, as almoſt to preclude the poſſibility of improving it: yet there can be little doubt that by the ingenuity of Britiſh artiſts it might be ſimplified a little, and produced at ſo cheap a rate that the funds of the Society might be able to add ſuch machines to their other apparatus for ſaving people from drowning. If ſuch machines were depoſited at the places where accidents of this kind moſt uſually occur, and ſome perſons in the neighbourhood inſtructed in the uſe of them, how ſpeedily might the unhappy victim be often reſcued from death! How infinitely preferable would this be to dragging, and how much more certain in its reſult, ſince the diver, when under water, could look round him for his object, and proceed directly to the ſpot! For ſuch a purpoſe it would be adviſable to make the machine ſo large that it would require an extra weight, more than equivalent to that of a man's body in water, to ſink it: the diver, by unhooking the weight or weights, would then be enabled to aſcend to the ſurface of the water with the patient in his arms.

XII. *Obſervations on Fire Balls. By* F. C. FULDA. *Read in the Phyſical Society of Gottingen, December* 7, 1796. *From* Profeſſor GMELIN's Göttingiſches Journal der Naturwiſſenſchaften, *Vol. I. Part* 2.

NOTWITHSTANDING the great progreſs which the ſciences have made in the preſent century, and though our knowledge of the atmoſphere has, in particular, been much enlarged,

enlarged, we are ſtill far from being able to explain all its phenomena, eſpecially thoſe of the luminous kind, in a manner ſufficiently ſatisfactory to the cautious and reflecting philoſopher. Though many, in conſequence of the important diſcoveries made reſpecting the electricity of the clouds, imagine that they have found in the electric fluid, ſo widely diffuſed, a certain key to all diſtant phenomena of a ſimilar kind, yet the greater part of them as mere obſervations, and the explanations given of them as mere hypotheſes, muſt be left to the deciſion of poſterity. It would be uſeleſs, and perhaps it is impoſſible, to mention all theſe phenomena in any certain order; but the moſt ſingular of them are large fire-balls (*bolides*), which, on account of their importance in natural philoſophy, have in modern times excited univerſal attention *.

Reſpecting the origin and nature of theſe phenomena, which are but ſeldom ſeen, and always ſurpriſe us as it were accidentally, we can venture conjectures and explanations only when we have compared a ſeries of obſervations carefully made with the circumſtances by which they were at-

* On the 13th of July 1797, about 42 minutes after nine in the evening, I had the good fortune, when in company with ſeveral of my friends, to ſee a meteor of this kind. It appeared in the ſouthern part of the horizon, at the height of 8 or 10 degrees; had the form of a perfect globe or ſphere well defined at the edges, almoſt as large as the moon when at full, and proceeded in the ſpace of ſcarcely a ſecond, while its courſe was only marked by a fine white ſtreak of light, in an almoſt perpendicular direction towards our horizon, which was confined by houſes, and diſappeared behind them. Its colour and ſplendour near the middle were ſometimes of a dazzling white. The heat during the day, and in the evening, was conſiderable. The thermometer varied from 18 to 20 of Reaumur, and between the hours of four and five in the afternoon there had been a ſtorm in the ſame quarter of the heavens. At the ſurface of the earth there was a perfect calm, and in the evening the weather-cocks ſhewed that a light ſouth-weſt wind prevailed at ſome height in the atmoſphere. At the time of this phenomenon the earth was overſpread by a pale miſt, through which no ſtars could be perceived, and which the following night became a thick fog.

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tended, and have then deduced from them general conclusions *, which in the hands of the mathematician may conduct with the greatest certainty to a knowledge of their nature, and of the causes by which they are produced. I shall endeavour, therefore, to present the reader with such conclusions drawn from a series of observations made in regard to fire-balls, not with the intention of giving any explanation from them myself, but in compliance with the excellent rule laid down by Le Roy, when he says, speaking of this circumstance: "Let us always collect observations without being too forward to deduce consequences from them, and to explain phenomena respecting which we have at present so little knowledge †.

Some of the observations here given, as well as the conclusions drawn from them, have been already employed by Dr. Chladni, in a particular treatise ‡ to explain the origin of the mass of iron found by Professor Pallas in Siberia §, and other masses of the like kind, as well as stones which, according to accounts worthy of credit, are said to have fallen from the heavens, and therefore more in a geological than a meteorological view. My object is quite different. I propose, notwithstanding the difficulty of determining properly from the observations made to what class of luminous appearances such phenomena belong ||, to collect together those accounts which have been considered, at least with some proba-

* Il faudroit etudier avec soin les rapports de ces *phénomènes* avec les autres phénomènes atmosphériques; rechercher l'état du ciel avant et après leur apparition, déterminer les tems, les circonstances et lieux ou ils sont les plus communs, savoir pourquoi ils sont rares, et pourquoi ils arrivent. Que d'observations à faire! Que d'observateurs à occuper! —*Sennebier.*

† Memoires de l'Academie des Sciences, 1771.

‡ Ueber den Ursprung der von Pallas gefundenen und anderer ihr ähnlichen Eisen-Massen, von C. F. F. Chladni. Riga 1794.

§ See Philosophical Magazine, Vol. II. p. 1.

|| Henry Barham, as mentioned in the Philosophical Transactions, vol. xxx. p. 837, saw in Jamaica, in the year 1700, a flaming fire-ball, of the size

probability, as alluding to the fame kind, and in moft cafes juft as they were given by the obfervers, without paying attention to any particular mode of explanation, in order to affift thofe whofe attention is occupied with the origin and nature of thefe bodies, to examine the old and new hypothefes formed refpecting them, or to fupport future ones, if neceffary. Thefe meteors appear, then,

1. In every climate. Of fifty obfervations with which I am acquainted, three were made immediately under the equator *; three in a fouthern †, and 44 in a northern latitude: and this difproportion arifes merely from the greater number of accounts brought to us from the latter, and the greater attention of the obfervers; for we are affured by Forfter, that he faw feveral fire-balls in the fouth feas ‡.

2. At every feafon of the year. I am acquainted with obfervations made in every month except September; and of thefe feveral were made, but between the 45th and 55th degree of northern latitude, in all the months except April,

fize of a bomb, defcend towards the earth; but though the ground was dug up around the place where it feemed to fall, nothing could be perceived except burnt grafs and a fulphureous fmell. A violent ftorm, it is faid, had taken place a little before, which makes it highly probable that this phenomenon was nothing elfe than lightning, efpecially as Reimarus relates, that lightning has been feen to fall upon houfes and conductors in a globular form, and that a fulphureous fmell has been afterwards perceived: fee *Reimarus vom Bliz*, Hamburg 1794, p. 51, 155, 319. An obfervation of two balls proceeding towards each other before a thunder cloud, made by Hartman, in July 1758, feems to be of the like kind. See *Verwandfchaft der Elektrifchen Kraft mit den Lufterfcheinungen*, Hanover 1759, p. 237; and alfo a flafh of lightning mentioned by Reimarus, p. 12. Other inftances of the two phenomena being confounded, are noticed by Dr. Chladni in his work, p. 2.

* Ulloa's Voyage to South America. Lond. 1760. Vol. i. p. 354, and vol. ii. p. 226.

† Journal des Obfervations Phyfiques, Mathematiques et Botaniques, par Louis Feuillé. Paris 1714. Vol. i. p. 116, 119. and vol. iii. p. 92.

‡ Forfter's Obfervations, made during a voyage round the world, on Phyfical Geography, &c. p. 119.

June and September. It cannot, therefore, be said that, like storms, they appear more frequently at one time of the year than another.

3. At every period of the day. The hour when these phenomena took place is not indeed given by every observer, but observations have been made both by night and by day. The greater part, however, have been made in the evening, when, being more perceptible to the eye, it was less possible for them to escape notice.

4. They appear, for the most part, when the sky is serene. This remark is expressly made in regard to 26 of the above mentioned 50; and in regard to the rest it is to be concluded from concomitant circumstances, such as their height, &c. The heavens were often covered only with a pale mist *, and some few were seen to proceed from light clouds †, which gives us reason to suppose that they came from a greater height than these clouds.

5. Most of them were seen to move with a very rapid motion, and of those on the velocity of which observations have been made, that is said to have moved quickest which was seen in the month of November 1758, and which, according to the calculation of Sir John Pringle ‡, passed over thirty English or seven German miles in one second; a velocity greater by $3\frac{1}{2}$ miles in a second, than that of the motion of the earth in its orbit. The one said to have moved slowest is that which was seen by Balbus at Bologna, in the month of March 1719 §, and which proceeded, according to his reckoning, at about 1530 feet or 0,067 of a German mile in one second. But there is reason to conclude

* Breslauer Sammlungen von Natur-und Medicin-Geschichten. III. Jan. 1716, p. 544. Hanov. Magazin 1791, p. 1628.

† Breslauer Sammlungen xxix. Aug. 1724, p. 169. Compare Lichtenbergs Gothaisches Magazin, vol. iii. part 2. p. 92; vol. iv. part 2, p. 164.

‡ Philosoph. Transactions, vol. li. part 1. p. 218.

§ De Bonon. Scient. Instit. Comment. vol. i. p. 285.

that

that the movement of others*, the courſe of which, as might be conjectured from their long train, was not in the direction of the eye, muſt have been much ſlower. Some appear alſo, unleſs theſe be refuſed a place here, to be peculiar to one part of the heavens †.

6. They proceed from, as well as towards, all points of the compaſs. The greater part of them, however, have beyond all diſpute appeared in the northern or ſouthern parts of the horizon; but no general concluſion, in regard to their connection with the northern ‡ or ſouthern lights, can be drawn from this circumſtance, though ſome obſervations made in Sweden § ſeem to favour ſuch an hypotheſis.

7. They do not always move according to the direction of the wind. The third obſerved by Ulloa makes, perhaps accidentally, an exception; and the ſpindle-ſhaped meteor ſeen by M. Lichtenberg, at Gottingen, on the 12th of November ‖, was towards the S. S. E. the then direction of the wind, which however near the earth was very little felt. Beſides, their velocity was ſeldom or never proportioned to that of the wind; as during the moſt violent ſtorm it does not move above 100 feet per ſecond. When ſuch meteors have appeared, it has been generally calm; but ſome of them were followed by wind ¶, and Forſter obſerved that after each fire-ball which he ſaw a violent wind took place.

* Breſlauer Sammlungen, iv. May 1718, p. 1077; Philoſoph. Tranſactions, vol. xliii. No. 477, p. 524; and Gothaiſches Magazin, vol. iv. part 2. p. 164.

† Hof in Acta Litteraria et Scient. Sueciæ, an. 1734, p. 78; and De Genſſance in Hiſtoire de l'Acad. des Sciences. Paris 1738. p. 36.

‡ Bergman's Phyſic. Beſchreibung der erdkugel, vol. ii. p. 78. Bernſtoff in Rozier's Journal de Phyſique, 1784, p. 115; and Blagden in the Philoſoph. Tranſactions for 1784, p. 229.

§ Hof and Celſius in Acta Litteraria et Scient. Sueciæ, an. 1734, p. 78 and 81. Giſler in Schwediſche Abhandlungen, vol. xxv. p. 65.

‖ Hannövriſches Magazin, 1791, p. 1626.

¶ Acta Litteraria Sueciæ, 1734, p. 78; and Chladni in Gothaiſches Magazin, vol. xi. part 2. p. 112.

8. They almoſt all fell towards the earth, and conſequently from a rarer to a denſer atmoſphere, as in moſt caſes might be concluded from their ſoon becoming conſiderably enlarged. Some of them, however, particularly thoſe which moved ſlowly, ſeemed to proceed in a horizontal direction over the ſurface of the earth; but none of them, according to every appearance, moved upwards. Their motion, therefore, cannot be explained in the ſame manner as that of ſky-rockets *, where the ſuperior air is rarified by the flame, and that below condenſed.

9. Their form was ſometimes perfectly globular, and ſometimes more ſpindle ſhaped; ſo that their length often occupied ſeven or eight degrees of the heavens. When obſerved to move with great velocity, they had a long tail behind, which aroſe chiefly from the continuance of the impreſſion made on the eye †. Others, however ‡, and particularly thoſe which moved ſlowly, ſhewed that a part of the tail belonged to the body itſelf; and it would appear that the long train which marks their courſe, ought often to be explained rather by traces left behind them than by mere impreſſion §.

10. Their apparent magnitude was very different, but on ſeveral occaſions greater than that of the moon ||.

* Gothaiſches Magazin, vol. iii. part 2. p. 95.

† Intelligimus magis qua appareat ſtella, quam qua eat. Itaque velut igne continuo totum iter ſignat, quia viſus noſtri tarditas non ſubſequitur momenta currentis, ſed videt ſimul et unde exſilierit et quo pervenerit. Quod fit in fulmine, longus nobis videtur ignis ejus, quia cito ſpatium ſuum tranſilit, et oculis noſtris occurrit univerſum, per quod dejectus eſt. At ille non eſt extenti corporis per omne qua venit. Senecæ Queſt. Natur. lib. i. cap. xiv.

‡ Robinſon in the Philoſoph. Tranſactions for 1784, part i. p. 225.

§ Breſlauer Sammlungen, i. 1717. p. 157; Philoſoph. Tranſactions, vol. xli. part 2. p. 870, vol. xlii. p. 1; and Tranſactions of the American Philoſoph. Society, vol. ii. p. 173.

|| Hiſtoire de l'Acad. des Sciences. Paris 1761. p. 28. Gothaiſches Magazin, vol. iii. part ii. p. 92.

11. Only

11. Only a few of them had an apparent motion round their axes *.

12. The greater part of them diffused a very lively dazzling light †; the fewer number a faint light. Their colour and splendour were very different and variable; sometimes red, sometimes blue, sometimes violet, sometimes in part yellow or dazzling white, and some exhibited the prismatic colours ‡. Several have been seen to burn with a bright flame, and others as if in a state of ignition.

13. Their real diameter, as far as could be ascertained, sometimes by conjecture and sometimes by actual measurement, was always very considerable. The diameter of that respecting which Sir John Pringle made calculations from various observations he collected, and of that seen by Mr. Rittenhouse § at Philadelphia, in the month of October 1779, were at most about half a German mile.

14. They seem to have originated at a very different, though most of them at a very considerable height above the surface of the earth. At any rate all of them, whose mean or greatest height was subjected to any calculation, exceeded that of the highest clouds, as clouds are scarcely perceptible at the height of 13,500 toises; and Silberschlag found the greatest height of the fire-ball, which appeared in July 1762, to be 19 German miles, or 72,276 toises. On this account their origin, as Reimarus and Chladni have already sufficiently shewn, is not to be ascribed merely to electricity, though some have considered them as occasioned by the action of the electric fluid between the clouds and the northern lights, which would agree exceedingly well with

* Nova Acta Nat. Curios. vol. i. p. 348. Theorie der am 23 sten. Jul. 1762 erschienenen Feuerkugel von J. E. Silberschlag. Magd. Stend. u. Leipz. 1764. 4.

† Philosoph. Transactions, vol. xli. part 1. p. 346.

‡ Gothaisches Magazin, vol. iv. part 2. p. 164. Hannövrisches Magazin, 1791, p. 1627.

§ Transactions of the American Philosoph. Society, vol. ii. p. 175.

their

their actual height; as, according to the measurement of Bergman, Kastner and Lambert *, the northern lights have an altitude of more than 20 or 30 German miles, and according to every appearance no fire-balls have been seen higher. On the other hand, this general conclusion led Halley †, Franklin ‡, and Rittenhouse §, to the grand idea, which Dr. Chladni has defended with so much ingenuity, that these phenomena, as well as shooting stars, are cosmical meteors belonging to the atmosphere of the sun, which meeting our earth in its course round that luminary are inflamed, by some cause or other, when they enter the earth's atmosphere. The phenomenon also seen by De Genssance at Paris in the month of July 1738, and the like observation of falling stars on the highest mountains, as well as on the surface of the sea ||, but in particular the new distant luminous phenomenon observed by M. Schroter ¶, will appear the more favourable to this hypothesis, as we have reason to suppose that there are processes carried on in our atmosphere with which we are as little acquainted as with those carried on in the interior parts of the earth.

15. The time of their duration was very different: that observed by De Genssance continued half an hour; at other times their duration has seldom been above a minute. Few or none of them, however, have been observed from the commencement of their appearance till the time when they disappeared.

16. Many of them in their course threw out sparks, and the greater part of them were seen to divide themselves into several, sometimes larger, sometimes smaller parts, before they

* Göttingischer Taschen-Calendar, 1778, p. 52.

† Philosoph. Transactions, No. 341.

‡ Gothaisches Magazin, vol. iv. part 2. p. 114; and vol. ix. part 3. p. 173.

§ Transactions of the American Philosoph. Society, vol. ii. p. 175.

|| Brydone in the Philosoph. Transactions, vol. lxiii. part 1. p. 167.

¶ Gothaisches Magazin, vol. xi. part 1. p. 86.

entirely disappeared. This division also seems to oppose the hypothesis of a tract of inflammable air set on fire *, which Dr. Chladni has sufficiently refuted on other grounds.

17. This bursting into pieces was for the most part accompanied with a rumbling noise like thunder, or a sudden report. This was observed to be the case in regard to 27 of the 50 above mentioned; and very often two or more reports have been heard in succession, without the large ball being divided into smaller ones, and without these being still farther shattered. But as these reports were heard at a very great distance †, and as many which did not appear to be more remote, but nearer, have burst without any report; a question arises, whether we are to consider, as Dr. Chladni does, this violent bursting as peculiar to all these phenomena?

18. Several, after bursting, seemed to dissolve into smoke ‡, and, according to the observation made by Celsius in the month of March 1731, a visible smoking stripe seemed to be previously inflamed. The greater part of them, however, after exploding, left no visible traces behind.

19. In some cases, after their disappearance, a sulphureous smell was perceived §, like that perceived after lightning has fallen, and which gave occasion to Muschenbroek's hypothesis of an accumulation of sulphureous inflammable vapours that arise from volcanoes and subterranean pits, and being driven together by the winds form clouds, that by some accident or other are set on fire; but which, however, can as little be reconciled with their general prodigious height, as Silberschlag's oily and slimy vapours.

* Gehlers Phys. Wörterbuch, art. Feuerkugel.

† Allgem. Historie der Reisen, vol. ix. p. 564; and Philosoph. Transactions, vol. iii. part 1. p. 163.

‡ De Bonon. Scient. Instit. Comment. vol. i. p. 285; Philosoph. Transactions, vol. xli. part 2. p. 870, vol. xlii. p. 1; and Hist. de l'Acad. des Sciences, Paris 1753, p. 73.

§ Breslauer Sammlungen, i. p. 157; Philosoph. Transactions, vol. l. p. 299; and Goth. Magazin, vol. xi. part 2, p. 112.

20. As

20. As fcoriaceous maffes have frequently been either actually feen to fall at the time of the difappearance of thefe phenomena, or have been found foon after on the furface of the earth, and as it is fufficiently proved by various accounts that ftones have fallen from the atmofphere, Dr. Chladni concludes that both thefe phenomena are connected; but this can be determined only by future accurate obfervations.

XIII. *A Communication from Mr.* W. H. PEPYS *jun. Member of the London Philofophical Society, containing an Account of fome interefting Experiments on the Production of Artificial Cold, in one of which Fifty-fix Pounds of Mercury was frozen into a folid Mafs.*

THE freezing or fixing of mercury has been the means of proving it to be a metal poffeffing the principal properties and characteriftics of other metals, as fplendour, malleability, and a cryftallifed ftructure when reduced to a folid form. Gmelin was the firft who ever obferved mercury at fuch a low temperature as leads to a belief that a partial congelation had taken place, though he did not then fufpect the fact; but "De L'Ifle was probably the firft perfon upon earth who faw quickfilver reduced to a folid form by cold, and ventured to credit the teftimony of his fenfes *." This happened at Yakutfk in Siberia, in 1736, where the natural temperature was fo low at the time as to produce the effect without the aid of artificial means.

Since that period the production of artificial cold, by means of various mixtures, fufficiently intenfe to freeze mercury, has employed the abilities of the moft experienced chemifts and philofophers, as Braun, Blumenbach, Hutchins, Lambert Bicker, Fothergill, Cazalet, Guthrie, Caven-

* See Dr. Blagden's paper on this fubject in the Phil. Tranfactions for 1783.

dish, &c. and latterly Walker, who, in his treatise on that subject, seemed to have exhausted the whole train of mixtures, and certainly has shewn considerable ingenuity in the contrivance of the instruments and apparatus he employed to accomplish the end he had in view: but, though I am possessed of the principal part of them, and repeated his experiments with the greatest care and attention, I cannot say I succeeded in all of them. The materials employed by Seguin for frigorific mixtures are certainly the best that have yet been proposed, or perhaps can possibly be devised. Considering the muriats as a class of salts best suited for the purpose, and having tried them all, he gave the decided preference to muriat of lime in crystals. His method was to mix the crystals, previously pulverised, with an equal weight of uncompressed snow. My friends Allen and Lawson were, I believe, the first who in this country tried that method: this was in December last; and they succeeded perfectly in freezing the mercury.

Determining to make the experiment with accuracy in respect to the weight of the materials employed, and on such a scale that it might be repeated by any one, on the 30th of January last we collected a quantity of snow for the purpose. The temperature of the laboratory at the time was 40°. It may not be improper to mention here, that the thermometer employed in this and the other experiments which followed was filled with tinged alkohol, and accurately divided according to Fahr. scale, as mercurial thermometers cannot be resorted to for determining degrees of temperature at or under the freezing point of that metal. Having put into an earthen pan equal parts of muriat of lime of the temperature of 40° and snow at 32° above 0°, we found that the temperature of the mixture, as soon as liquefaction took place, was 32° below 0°. Into this mixture we immersed, each in separate vessels, 8 oz. troy of muriat of lime, and the same weight of snow, by which means, and with very little trouble, they were cooled down to 5° above 0°, the mixture gaining

gaining a proportionate increaſe of temperature by the heat which had paſſed into it from the immerſed ſnow and muriat.

We now placed a half-pint Wedgewood's cup within a white ſtone-ware jar, inſulating it, agreeably to a method ſuggeſted by our friend Howard, with three corks placed at equal diſtances round the veſſel, and one at the bottom for the cup to reſt upon. This prevented the cup from coming in contact with the jar, which we now placed, with the cup in it, in the mixture that had ſerved for cooling the materials down to + 5° *, adding to the mixture a little more muriat of lime at + 40° and ſnow at + 32°. By this means we ſecured the advantage of having a cold atmoſphere within the jar all round the inſulated cup.

Upon mixing the cooled ingredients, which were now put into the cup, the thermometer, being immerſed in the mixture, ſunk to — 50°. Four ounces of pure mercury at + 40°, in a ſmall thin glaſs retort, were then introduced into this mixture, which in 15 minutes became perfectly fixed. We obſerved that it congealed from the circumference towards the centre, in the ſame way as wax or reſin fixes in cooling.

We now broke the retort, and gave the mercury ſeveral blows with the beak of a hammer, which indented, and at laſt fractured it: the fracture was ſimilar to that of zink, but with facets more cubical. Inadvertently taking up a piece of the ſolid mercury, I experienced a ſenſation as if I had received a wound from a rough-edged inſtrument. I threw it from me as I would have done a piece of red-hot iron, and was not a little alarmed when I found that the part of my hand which had been in contact with the metal, immediately after loſt all ſenſation, and became white and dead to the view.

The mercury in the mean time had become fluid. The time that had paſſed from taking it out of the mixture might have

* The ſign + denotes above, and the ſign — below 0°.

have been about two minutes; but the accident that happened to my hand prevented me from noting it exactly. On trying the temperature of the mixture, I now found it – 42°: the addition of fome fnow, which had been cooled for the purpofe while the preceding experiment was going on, reduced it again to – 50°.

We now put into the mixture a glafs tube containing fome mercury. In two minutes it was completely fixed. We broke the tube, and bent the cylindrical piece of mercury into an acute angle, by means of pincers: we attempted to ftraiten it again, but it became fluid during the operation.

Several fubftances in proper veffels were now tried in the cold mixture. Sulphuric ether exhibited no figns of congelation: rectified fpirit of turpentine became thick and nearly confiftent at – 50°: pure concentrated fulphuric acid was fixed: acetic acid likewife was fixed: nitric acid became thick and ropy. On muriatic acid the cold had no effect.

On the 7th of this month (Feb.) we repeated our experiment, in the prefence of a number of our acquaintance, with the fame fuccefs as before.

Encouraged by the fuccefs of thefe experiments, we refolved to attempt one of fome magnitude. Accordingly, on the following day, my friend Allen, who is a zealous and able chemift, ftarted a bullion of mercury for the purpofe; and, having weighed 56 lbs. avoirdupoife, we prepared every thing neceffary for fixing this quantity.

The mercury was put into a ftrong bladder and well fecured at the mouth, the temperature of the laboratory at the time being + 33°. A mixture confifting of muriat of lime 2 lib. at + 33° and the fame weight of fnow at + 32° gave – 42°. The mercury was put as gently as poffible into this mixture (to prevent a rupture of the bladder), by means of a cloth held at the four corners. When the cold mixture had robbed the mercury of fo much of its heat as to have its own temperature thereby raifed from – 42° to + 5, another mixture, the fame in every refpect as the laft, was made, which

which gave, on trial with the thermometer, − 43°. The mercury was now received into the cloth, and put gently into this new mixture, where it was left to be cooled ſtill lower than before.

In the mean time five pounds of muriat of lime, in a large pail made of tinned-iron and japanned inſide and outſide, was placed in a cooling mixture in an earthen-ware pan. The mixture in the pan, which conſiſted of 4 lib. of muriat of lime and a like quantity of ſnow, of the ſame temperature as the former, in one hour reduced the 5 lib. of muriat in the pail to − 15°. The mixture was then emptied out of the earthen pan, and four large corks, at proper diſtances, placed on its bottom, to ſerve as reſts for the japanned pail which was now put into the pan. The corks anſwered the purpoſe already mentioned, that of inſulating the inner veſſel, while the exterior one kept off the ſurrounding atmoſphere, and preſerved the air between the two at a low temperature.

To the 5 lib. of muriat of lime which had been cooled as already noticed to − 15°, and which ſtill remained in the metallic veſſel, was now added ſnow, uncompreſſed and free from moiſture, at the uſual temperature of + 32°. In leſs than three minutes the mixture gave a temperature of − 62°: a degree of cold which I believe was never before produced in this country, being 94° below the freezing point of water.

The mercury, which, by immerſion in the ſecond cooling-mixture to which it was expoſed, we found by this time reduced to − 30°, was now, by the means employed before, cautiouſly put into the laſt-made mixture of the temperature of − 62°. A hoop, with net-work faſtened to its upper edge, and of ſuch a breadth in the rim that the net-work, when loaded with the bladder of mercury, could not reach its lower edge, was at the bottom of the mixture, to prevent the bladder from coming in contact with the veſſel; by which means the mercury was ſuſpended in the middle of the mixture. As ſoon as the bladder was ſafely depoſited on the net-work, the veſſels were carefully covered over with

 a cloth,

a cloth, to impede the paſſage of heat from the ſurrounding atmoſphere into our materials. The condenſation of moiſture from the atmoſphere by the agency of ſo low a temperature was greater than could have been expected: it floated like ſteam over our veſſels, and, but for the interpoſed covering, would have given our mixture more temperature than was deſirable.

After one hour and forty minutes we found, by means of a ſearcher introduced for the purpoſe, that the mercury was ſolid and fixed. The temperature of the mixture at this time was − 46, that is 16° higher than when the mercury was put into it.

We now regretted that we had not flung the hoop and net-work in the ſame way as the ſhell of a beam is ſuſpended, which would have enabled us to lift it out of the mixture at once with the bladder and its contents; but having overlooked this proviſion, we were obliged to turn out the whole contents of the pail into a large evaporating capſule made of iron, which was not effected without the mercury ſtriking againſt its bottom, and at the ſame time receiving a conſiderable increaſe of temperature. The bladder was now cut. The eagerneſs of our friends, of whom ſeveral were preſent, to be in poſſeſſion of pieces of the ſolid mercury, which had fractured by the fall it had received, was paſt deſcription. Forgetting, and perhaps not being aware of the conſequence, ſome ruſhed their hands into the frigorific mixture, while ſome ſeized on pieces which others, having ſelected with their eyes as their prize, alſo laid hold of at the ſame moment, and conſequently each graſped them harder than otherwiſe they would have done. The acute pain that inſtantly followed, quickly recalled their recollection, and, but for the ſufferings of the individuals, the ſcene would have excited no ſmall degree of mirth: ſome clapt their hands into their mouths, others ſhook them, blew on them, or rubbed them againſt their clothes; and all were more or leſs

 alarmed

alarmed at the dead appearance of the parts that had been ſo ſuddenly robbed of heat by the frozen metal *.

The larger pieces were kept for ſome minutes before fuſion took place, while others were twiſted and bent into various forms, to the no ſmall gratification and ſurpriſe of thoſe who had never witneſſed or expected to ſee ſuch an effect produced on ſo fuſible a metal.

Though mercury in the ſtate in which we had it, exhibited a conſiderable degree of ductility and malleability, we cannot thence infer the degree in which they would be found to belong to it, could it be reduced to a temperature much more conſiderably under its freezing point, which ſeems to be at about − 39° or − 40°. At the time that we bent and twiſted it, it may be conſidered as having been in a proportionate temperature to iron near its point of fuſion, when, as is well known, it will hardly bear the ſmalleſt blow of a hammer.

As the apparatus employed in theſe experiments was extremely ſimple, a ſhort deſcription of them may not be unacceptable. Fig. 1 (*Plate II.*) repreſents that employed in the firſt experiments; and only viewing the figure will con-

* It was a conſiderable time before ſenſation and the natural colour was reſtored to the parts, which however returned without any other means being employed than ſuch as have been mentioned. It is eaſy to conceive that the injury was little more than ſkin deep, like what takes place from touching a hot metal, without allowing it to remain long enough in contact with the ſkin to produce a wound; but what is very ſingular, almoſt every individual compared the ſudden pain he experienced to that produced by a *burn or ſcald!* One gentleman, who called accidentally while we were preparing for our experiment, but who had no acquaintance with the ſubject, not being able to conceive how the effect propoſed could be produced by the mixture, was deſired to take a little ſnow in one hand and muriat of lime in the other: "they were neither of them colder than he expected to find them:" then to put the ſnow into the hand that held the muriat. The ingredients had hardly come in contact when he threw them from him, exclaiming, "Cold!—'Tis a red-hot coal!"

vey to any one a complete idea of the arrangement, as it exhibits the retort containing the mercury, ſurrounded by the cooling-mixture in the half-pint cup, which is inſulated by means of the corks, and prevented from coming in contact with the ſtone-ware jar — the ſpace between the latter being occupied only with cold air, preſerved in that ſtate by means of the frigorific mixture in the exterior veſſel, and which ſurrounds the jar.

Fig. 2 repreſents the apparatus employed in the large experiment, which is ſimilar in its arrangement to the former; only that the cold atmoſphere round the japanned pail had no exterior cold mixture to defend it; which, however, was the leſs neceſſary, as the earthen pan was of conſiderable thickneſs, and had acquired the temperature of the mixture that had been employed in cooling the 5 lib. of muriat of lime.

In experiments of the kind I have deſcribed, all the exterior veſſels ſhould be of earthen-ware or wood, which being bad conductors of heat, prevent the ingredients from receiving heat from the atmoſphere and ſurrounding objects with the ſame facility that they would through metals; and, for a ſimilar reaſon, the interior veſſels are beſt of metal *, that they may allow the heat to paſs more readily from the ſubſtance to be cooled into the frigorific mixture employed for that purpoſe.

Muriat of lime is certainly the moſt powerful, and at the ſame time the moſt economical ſubſtance that can be employed for producing artificial cold; for its firſt coſt is a mere trifle, being a reſiduum from many chemical proceſſes, as the diſtillation of pure ammonia, &c. and often thrown away: beſides, it may be repeatedly uſed for ſimilar experiments, nothing being neceſſary for this purpoſe but filtration and evaporation to bring it to its firſt ſtate. The eva-

* When we uſed a glaſs-retort to contain the mercury, it was that we might be able to ſee ſuch phenomena as might preſent themſelves during its congelation.

poration ſhould be carried on till the ſolution becomes as thick as a ſtrong ſyrup, and upon cooling the whole will become cryſtalliſed: it muſt then be powdered, put up in dry bottles, well corked, and covered with bladder or cement, to prevent liquefaction; which otherwiſe would ſoon take place, owing to the great affinity the muriat has for moiſture.

The powerful effects produced by the frigorific mixture of muriat of lime and ſnow preſents a wide field for experiments to determine the poſſibility of fixing ſome of the gaſes by intenſe cold. As ſoon as an opportunity offers, we mean to attempt ſome experiments with that view, of the ſucceſs of which the earlieſt account ſhall be ſent to the Philoſophical Magazine, for the information of thoſe who are fond of ſuch purſuits.

XIV. *Letters from ſome of the Men of Science engaged in the French Expedition to Egypt.*

[Continued from Vol. II. page 417.]

LETTER III.

Cairo, Thermidor 26th.

I CONFORM to the manners of the Turks. We all wear whiſkers, becauſe a bare chin is a ſign of ſlavery; and, though we are here maſters, the force of prejudice makes the Turks believe that thoſe Frenchmen who appear without whiſkers are the ſlaves of the reſt.

I have juſt come from the Inſtitute of Cairo. Two palaces of the beys, and two other houſes, which belonged to rich individuals, all contiguous, ſerve to lodge the men of letters and artiſts. Theſe houſes afford us, perhaps, more convenience than is found at the Louvre, and, at leaſt, as much magnificence. An immenſe garden, the ſuperficial content of which is equal to thirty-five French acres, well planted, and having a number of raiſed terraces, which the waters of the Nile, during the time of its inundation, never reach, is deſtined for botany and the cultivation of plants.

The hall where the Inſtitute meets is already decorated with the richeſt French furniture found in the houſes of the Mamalouks. Beſides other articles, there are, a very large fine clock by Berthout, and a Japan vaſe of great ſize.

I am juſt now employed in collecting all the curious animals, which I was told were to be found at the houſes of the Mamalouks. Our place for keeping birds is already completed; and in a little time we ſhall be better eſtabliſhed than if we were in the *Jardin des Plantes*. But the greateſt ambition of the members of the Inſtitute is to tranſmit to you the firſt volume of our memoirs, before thoſe of the French Inſtitute ſhall appear. We are labouring for this purpoſe with great aſſiduity. You will find two memoirs of mine, which I hope will meet with your approbation.

I wiſh to give you ſome details, particularly in regard to what I have obſerved in this country; but too many events have taken place, and I ſee ſo many things highly intereſting to the philoſopher that I really am at a loſs what to ſay or where to begin. I ſhall, therefore, give you an account only of a breakfaſt and dinner in which I participated, as they will ſerve to convey ſome idea of the manners of the Egyptians.

General Menou, being proviſional commandant of the province of Roſetta, was deſirous of making a tour through it; and as there are no inns here, and as he was informed, beſides, that it is cuſtomary for the commandant to accept a dinner from the chief of the canton, the general conformed to that uſage. We accompanied him, to the number of fifteen, and had a guard of twenty ſoldiers. Ninety-ſix diſhes, all touching each other, and diſpoſed in the form of an ellipſe, were ſerved up, on the ground, which was covered, however, with mats and carpets. We were treated in a high ſtyle. The entertainment did not conſiſt of ſeveral ſervices, but, what amounts to the ſame thing, of ſeveral ſtories. The largeſt articles were in diſhes of a proportionate ſize. All theſe diſhes occupied the lower part: they were of a circular form and made of tin, as in France. Three diſhes, placed quite cloſe to each other, left an empty ſpace in the middle, which was entirely concealed by a ſmaller diſh. Theſe diſhes contained the dainties, which are made by the real Egyptian women. The company firſt attacked theſe in order to get rid of them, and that they might have acceſs to the lower range. Theſe dainties conſiſted of ſeven or eight kinds of cheeſe, molaſſes baked with flour paſte, fricaſſes of rice and mutton baked with raiſins, prunes, figs, grenadilloes, &c.

The ſolid diſhes were fowls dreſſed with rice, or prepared other ways, &c. The ellipſis forming the whole of the ſervice was bordered with half a cubical foot of bread of twelve kinds and different forms: there were cakes of various ſorts, elliptic and circular bread, &c. &c.

The Cheik invited us all to ſquat down around, and we ſoon ſaw the Turks in the company put their hands into the diſhes, take the liquids in their palms and the ſolids in their fingers, and in that manner convey them to their mouth. We were obliged to do the ſame; for we had neither ſpoons nor forks.

The dinner, which we partook of in a neighbouring village, was not much different from our breakfaſt, except by the abſence of milk diſhes, and a leſs variety in the kinds of bread. The new diſhes were, a whole ſheep in the middle, and various other viands around, either roaſted or fried in a very whimſical manner. The principal domeſtic, who waited on us, croſſed the ſervice through a paſſage which he made by taking away ſome of the diſhes. When he cut up the ſheep, he divided it into pieces by means of his hands and a knife, or broke and tore it without much ceremony, and diſtributed a part to each.

The Cheik who entertained us at breakfaſt had a ſon 34 years of age, a rich farmer, and, next to his father, the moſt conſiconfiderable man in the village. We wifhed this young man's fon to breakfaft with us, and we defired him to place himfelf at table; but he blufhed as if we had afked him to commit a crime. His father told us that his child would never be prevailed on to fit down where his grandfather fat, and above all to eat in his prefence: that the profound refpect he entertained for his grandfather, made him impofe this on himfelf as a law. We then invited the fon to fit down; but he made the fame obfervations in regard to himfelf, and with a religious folemnity which furprifed us. General Menou requefted the grandfather to order his children and grand-children to partake in the entertainment; and after fome hefitation he agreed, faying, that it was contrary to cuftom, but that it gave pleafure to his paternal heart. The children obeyed; but they had an air of referve and timidity during the whole time they were eating. They made hafte to finifh their meal, and retired fpeedily according to the cuftom of the country, which requires thofe who have no appetite to depart.

After General Menou and his company had finifhed their repaft, the foldiers came, in their turn, to feed upon what we had left. The firft, and this fecond company, who confifted of jolly fellows of a keen appetite, ate at moft two thirds of what had been ferved up, after which the poor of the village were invited. Thefe regaled themfelves with what remained. They entirely emptied the difhes, for which they contended, and which they tore from each other in a manner that afforded us much amufement.

Thefe Cheiks behaved with fo much liberality only becaufe they are authorifed by the laws of the country, when a commander in chief takes a repaft with them, to reimburfe themfelves for the expence they have been at, by an impoft which they levy immediately; and as it is therefore the village which treats, the inhabitants have a right to partake in the feaft, and to eat up what remains on the table of their lord. But thofe who actually pay do not participate in the entertainment: the poor in all countries escape such assessments, and people who are in easy circumstances disdain to go and eat fragments.

Upon the whole, the Egyptians in the country are exceedingly miserable: so much so indeed that the imagination can hardly conceive it. Would you believe that the greater part of the villages consist almost entirely of earthen huts, which are not three feet in height; that the aperture through which these miserable creatures enter their kennels is a circular hole of a foot and a half diameter, and that this hole remains always open; that there is no room in these huts, but what is necessary for the husband, wife and children, all huddled together, to sleep upon; and that, to enter these wretched habitations, they are obliged to creep on all fours? A place built up of earth, on which they bake their bread, occupies the third of the hut; two stones to grind corn, a coffee-pot to make coffee, and a bag containing tobacco, are all the furniture of these poor peasants. They never eat flesh, but they all drink coffee in the morning. The Turks cannot live without coffee and tobacco. Besides these, they seem to be acquainted with no wants. They drink their coffee without sugar, and with the grounds: the more abundant the latter are, so much the more agreeable it is to their taste.

LETTER IV.

Cairo, Fructidor 11.

THE members of the National Institute have founded here an establishment like that of Paris. They have associated with them some of the men of letters and artists who followed the army, and some military men have been admitted members also. Generals Kleber, Dessaix, Regnier, Andreossi and Cafarelli; Salkowski aid-de-camp to the commander in chief, and Sucy chief commissary, have been likewise admitted. This establishment has a very beautiful situation, and in a little time we shall have a botanical garden. A menagerie has already been begun to be formed, and there will soon be a public library, an observatory, a cabinet of philosophical instruments, a chemical laboratory, a hall of antiques, &c. Citizen Monge has been elected president; the Commander in chief, vice-president; and Cit. Fornier, secretary.

XV. *On the new Insect so prejudicial to Apple Trees; and a Method for extirpating them.*

WITHIN these few years an insect, before unknown in this country, has made its appearance in the British orchards, which, if means are not generally taken to root it out, will in a short period destroy every apple tree in the kingdom. It exhibits upon the trees the appearance of a white efflorescence, like what may be sometimes seen on stones in the fields: this seems, however, to be only the habitation of the insects, which exist in millions wherever they have once lodged themselves. On bruizing the efflorescence-like matter between the fingers, a deep red-coloured fluid like blood is expressed, and which probably is of that nature. Already have several valuable orchards been much injured by this insect, which corrodes the apple trees in such a manner as at last completely to destroy their organization and to kill them, without the proprietors, many of them at least, even once suspecting the cause. We hope what we now state will be the mean of making the fact generally known, and of inducing every person interested to co-operate in rooting them out.

We are happy in having it in our power to give them the recipe of a cheap composition discovered by William Forsyth, Esq. his majesty's gardener at Kensington, which has been found effectually to answer the purpose. It is as follows:

℞. To 100 gallons of human urine add as much cow dung as will bring the whole to the consistence of paint, with which anoint the infected trees about the end of March.

XVI.

XVI. *Second Communication from Dr.* THORNTON, *Physician to the General Dispensary, relative to different Trials made with the Factitious Airs.*

SIR, Feb. 20. Duke-street, Grosvenor Square.

I AM happy to inform you that I have been honoured from the most respectable quarters with several communications for your Magazine, relative to Pneumatic Medicine. Permit me to mention, that the only inducement I have for publishing in your work, is the great estimation I hold it in, the good of my fellow creatures, and a wish to fill up the chasm from the last publications by Dr. Beddoes on the Factitious Airs, until the establishment of a Pneumatic Hospital, the foundation of which is begun to be laid by that enlightened and patriotic physician, when the subject, he says, will be again revived by him. I am, sir,

To the Editor of the Philosophical Magazine.

Your obedient servant,
ROBERT JOHN THORNTON.

A REMARKABLE CASE OF SCROPHULA CURED BY VITAL AIR.

Miss Holmer, at 18, an amiable and accomplished young lady, the daughter of a wholesale ironmonger in the Borough*, so early as at the age of seven had the glands of the neck beginning to take on disease. First one gland under the ear, then another, and by degrees all the glands about the neck became enlarged, and went on gradually increasing. The same disposition also shewed itself by an affection of the eyes, for which this lady was nine months under the care of Mr. Ware. During the progress of glandular affection, she was under Messrs. Kent, Fearon, Bayley,

* This lady had all the benefit of country air; her father having a house at Vauxhall, and keeping his carriage, she had every advantage that fortune could give her. EDIT.

&c.

&c. &c. and Dr. Saunders. Mercury was ufed externally and internally until the teeth became loofened, bark, and fteel, and foda, or foffil alkali, given in profufion; but each practitioner in turn relinquifhed the cafe, recommending fea air, which was had recourfe to at fundry times. This young lady was latterly referred to John Hunter, who employed hemlock to an uncommon extent; and he alfo, as the fea air had been before tried without advantage, advifed the parents to do nothing farther, faying, with his ufual bluntnefs, that it was a cafe of that nature that whoever would undertake the cure would do it only with the intent of picking their pockets. When I firft faw the young lady, I obferved the glands of the throat, even from the nape of the neck, fo enlarged as to defeat all concealment, and forming one apparently hemogeneous mafs, extended even over the jaw-bones, which could not be felt, and fuffocation was threatened by preffure on the wind-pipe. Her relations ridiculed the idea of any farther application for this difeafe: but parental fondnefs urged an enquiry relative to the airs. The Rev. Mr. Townfend, rector of Pewfey, author of a very excellent work on phyfic, the Guide to Health, happened to be at my houfe when the lady arrived. Although he conceived highly of pneumatic medicine, as may be feen throughout this work, he told me, that he muft confider me as very bold if I could venture to undertake fuch a cafe, which he acknowledged to exceed any thing he had ever before feen; and Mr. Jones, an eminent apothecary in Mount-ftreet, declared, that if I produced a cure here, all he could fay was "that *miracles* had not ceafed." I, however, was not difcouraged, and the event has proved that we fhould not, having fuch new and powerful agents as the airs, readily give way to defpair.

In a month after commencing the inhalation of vital air (fix quarts daily mixed with thirty of atmofpheric), the knot of glands began to foften, yielding a little to external preffure: by degrees they feparated from each other, and thirteen

teen glands could be diſtinctly made out; the jaw-bones became liberated; and theſe, whether from preſſure of the glands, or imperfect oſſification, were bent up a little from their natural courſe; and, not to tire the reader, I ſhall finally remark, that in leſs than eight months the decreaſe was *five inches by meaſurement round the neck!* The hands, which before were unuſually cold, were comfortably warm during the whole time the vital air was inhaled, and the appetite and ſpirits increaſed. Mr. Cruickſhank obſerved, that during the time of inhaling the ſuperoxygenated air, the pulſe were raiſed about ſix beats in a minute, and became ſtronger. I muſt beg leave to mention here, that I alſo rouſed the abſorbents by both topical as well as internal remedies. But why I place ſuch a ſtreſs on the power of the vital air over this ſyſtem of veſſels, is, that from the experiment of Dr. Beddoes, which he made upon himſelf, while inhaling a ſuperoxygenated air, he became, he obſerves, conſiderably diminiſhed in bulk, although he eat twice as much as before, which I conceive could only ariſe from the ſuperior energy given to the abſorbents by the vital air:—But, however the wiſe ones, paſt the age of forty, may ſmile at *theory*, the *fact* or cure muſt remain undoubted, and it is intended to lay others (many of which are no leſs remarkable) in quick ſucceſſion before the impartial tribunal of the philoſophic world.

XVII. *Biographical Memoirs of* JAMES BERNOULLI. *From the* New Tranſactions of the Imperial Academy of Sciences at Peterſburgh.

JAMES BERNOULLI, licentiate of law, member of the Phyſical Society of Baſle, and correſpondent of the Royal Academy of Sciences at Turin, ſon of John Bernoulli, L.L.D. Profeſſor of Mathematics in the univerſity of Baſle, and of Suſannah Koenig, was born in that city on the 17th of

October

October 1759. Descended of a family rendered illustrious by three geometricians of the first class, and four other mathematicians of great reputation *, he distinguished himself early by his talents and genius, improved by uncommon assiduity and great application to study. Having finished his course of humanity, he was sent to Neufchatel to learn the French language, as is customary at Basle; and on his return, being admitted to the degree of master of arts, he entered his name as a student in law, and attended the lectures of the professors of law in that university with such success, that, in 1778, he found himself in a condition to

* 1. James Bernoulli, professor of mathematics at Basle, member of the academies of Paris and Berlin, born at Basle the 27th of December 1654, died there August 16, 1705.

2. John Bernoulli, brother of the preceding, professor of mathematics at Groningen, and afterwards at Basle, member of the academies of Petersburgh, Paris and Berlin, of the Royal Society of London, of the Institute of Bologna, &c. born at Basle, July 27, 1667; died there Jan 1, 1748.

3. Nicholas Bernoulli, nephew of the two preceding, professor of mathematics at Padua, afterwards professor of logic and then of law at Basle, member of the Academy of Sciences and Belles Lettres at Berlin, member of the Royal Society of London and the Institute of Bologna; born at Basle, October 10, 1687; died there November 29, 1759.

4. Nicholas Bernoulli, son of No. 2, licentiate of law, professor of law at Berne, and afterwards professor of mathematics at Petersburgh, member of the Institute of Bologna; born at Basle, January 17, 1695; died at Petersburgh, July 26, 1726.

5. Daniel Bernoulli, brother of the preceding, M.D. professor of mathematics at Petersburgh, afterwards professor of anatomy and botany at Basle, and then professor of natural philosophy in the same, member of the Academy of Petersburgh, Paris and Berlin, and of the Royal Society of London; born at Groeningen, January 29, 1700; died at Basle, March 17, 1782.

6. John Bernoulli, brother of the two preceeding, L.L.D. professor of eloquence, and afterwards of mathematics at Basle, member of the Acad of Paris and Berlin; born at Basle, May 18, 1710; died there, July 17, 1790.

support

support public theses on some very difficult points of law, and to receive his licence.

In 1780 he made a tour through several cantons of Swisserland in company with a few friends. The account of this short excursion, written in a plain manner, and without the name of the author, may be found in the third volume of the collection of travels published at Berlin by M. John Bernoulli.

The study of the law, and the application he gave to that branch of knowledge, was not able to extinguish his geometric spirit hereditary in the family. The lessons which had been given him by his father in his youth, and which were afterwards continued by his uncle, the celebrated Daniel Bernoulli, had increased his innate and irresistible propensity to the mathematical sciences. His rapid progress inspired him with the most flattering hopes, and induced the heads of the university to entrust him, in 1780, with the functions of his uncle, whose age and infirmities had rendered him incapable, for some time, of continuing his lectures on experimental philosophy. Mr. Bernoulli discharged these functions, till the death of his uncle, to the satisfaction of his auditors and the university; but he had not the pleasure of succeeding to the vacant chair, though his name was inserted in the list of candidates, because academic places at Basle are determined by lot, as well as all the other offices of the republic; and, on this occasion, the lot was unfavourable to him, a caprice of fortune which he had experienced in 1780, when he stood candidate for the chair of eloquence, at that time vacant. It was on this last occasion that he published his Theses on the Sublime. This double disappointment, joined to a strong desire of seeing the world, so natural and so powerful in young men, made him soon after form a resolution, agreeable to his prevailing taste for travelling, but which seemed likely, for a little time, to lead him aside from the literary career he had entered with so much applause; and he accepted the place of secretary to Count de Breuner, minister of the Imperial Court of Vienna to the Republic of Venice.

This office furnished him, indeed, with the wished-for opportunity of travelling, and of seeing successively a great part of Germany and Italy; but he could not travel always, and when he arrived at the place of his destination he became tired of a manner of life so little conformable to his way of thinking, and unfavourable to his taste for study. The society of a small number of literary men, and particularly of some geometricians of reputation, with whom he formed an acquaintance in Italy, and who received him in a manner suited to the name he bore, and to his personal merit, rendered his situation comfortable for some time. The friendship of these distinguished characters, among whom was the celebrated Lorgna, gave an agreeableness to his residence in that country, of which he long preserved a remembrance; but it could not extinguish the desire of soon finding a place where he might devote himself entirely to the mathematical sciences, and make use of the knowledge he had acquired in them, and of which he had given public proofs in the Memoirs of the Royal Academy of Sciences and Belles Lettres at Berlin, and in those of the Royal Society of Turin, who received him among the number of their corresponding members, during his residence in the latter city.

The disposition of mind above mentioned having, by means of John Bernoulli at Berlin, come to the knowledge of his countryman Mr. Fuss, the latter embraced a favourable opportunity of mentioning him to the princess of Daschkaw; and her excellency being already disposed to repair the loss which the Academy of Petersburgh had sustained by the death of Mr. Lexell, found that Mr. Bernoulli, independently of his personal merit, had a distinguished right to aspire at a place in an academy to which, since its foundation, his grandfather and two grand uncles had rendered essential services. Bernoulli, therefore, received

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the vocation of an adjunct, with a salary of 600 rubles, and the promise of being promoted in the course of a year. He accepted these offers with joy, and quitted Venice in the month of May 1786, taking the route of Swisserland to revisit his country and family before he went to Russia, where he was to establish himself, in consequence of his engagement, for at least three years.

Scarcely had he reached Petersburg when his ruling passion for travelling, or, what amounts to the same thing, his desire of acquiring knowledge, made him conceive the idea of participating in a sea voyage planned at that time, and for the execution of which several vessels, destined to sail under the command of M. Moulouski, were then fitting out. Mr. Bernoulli ardently wished to have a share in this expedition as astronomer, and conversed on that subject with the chief of the expedition, who received the proposal with pleasure, and promised to get the conditions they had agreed on sanctioned; but Mr. Bernoulli's friends induced him, though with great difficulty, to renounce a voyage the fatigues of which his weak and delicate constitution could not have supported.

Having abandoned this plan, which had given him much pain and uneasiness, he applied himself with the whole activity of his soul to physical mathematics. He laboured with great diligence, and surpassed so much the hopes conceived of him by the academy, that, before the expiration of the time fixed in his agreement, he found himself honoured with the title of ordinary academician. In the short space of little more than two years, he presented and read eight memoirs, inserted in the six first volumes of the *Nova Acta Academiæ Scientiarum Imperialis Petropolitanæ*, which display great penetration, a precise and acute mind, a solid judgement, and much more address in the management of analytical formulæ than could have been expected from a geometer so young, according to appearance, in the secret of analysis and the resources of calculation.

In

In 1788 his excellency Count d'Anhault appointed Mr. Bernoulli one of the profeſſors who inſtruct the Imperial corps of noble land cadets, charging him to teach algebra to the two firſt claſſes. In this office he diſtinguiſhed himſelf by much zeal and attachment to the duties it impoſed. He engaged, among other things, to make for the uſe of that corps an extract from Mr. Euler's Algebra; but death prevented him from commencing that work.

In 1789 Mr. Bernoulli married the youngeſt daughter of Mr. John Albert Euler. This marriage, which promiſed to the young couple durable felicity, and which united two names equally dear to the ſciences, and reſpectable in the republic of letters, was diſſolved, two months after it was ſolemniſed, by the tragical death of the huſband, who was carried off by a ſtroke of the apoplexy on the 3d of July the ſame year. A reſidence in the country, and the convenience of bathing every day in the Neva, had made him reſume a taſte for that practice and the exerciſe of ſwimming, which is ſo ſalutary, but ſo often fatal. He was well accuſtomed to the art, and conſequently had no fear of any unlucky accident; but whether he had neglected to dip his head firſt, or had bathed too ſoon after dinner, during the operation of digeſtion, which to him was difficult, or whether the germ of the malady had been already in his conſtitution, he ſuddenly became inſenſible and motionleſs; and though he was almoſt immediately drawn out by his brother-in-law, and though all the uſual methods were tried, aſſiſtance was uſeleſs, and the phyſicians unanimouſly declared that he had been ſtruck with a ſtroke of the apoplexy. It has been already obſerved, that Mr. Bernoulli was of a weak and delicate conſtitution. In the autumn of the year 1787 he was attacked by a nervous fever, which expoſed his life to great danger. He, however, recovered; and it is to be preſumed that his conſtitution would have been eſtabliſhed, and that it would have been able to reſiſt the ſeverity of the climate of Ruſſia, if Providence had not

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posed otherwise, by snatching him from the sciences and the academy in the 29th year of his age.

To an open, free, and tractable disposition, Mr. Bernoulli joined much modesty and mildness—qualities which procured him the friendship and esteem of all those with whom he was acquainted, and which justified, as much as his learning, the deep regret occasioned by his premature death. The following is a list of his writings:

Dissertatio Inauguralis Juridica. Basiliæ, 1778.

Theses Juridicæ. Ibid. 1779.

Theses de Sublimi. Ibid. 1780.

Description of a Tour through Swisserland, in the month of August 1780. (In John Bernoulli's Collection of Short Tours, Vol. III.)

Lettre sur l'Elasticité. (In the Journal de Physique de l'Abbé Rozier, Suppl.)

Memoire sur la Theorie d'un Instrument qu'on pourroit nommer Machine Balistique. (Mem. de l'Acad. Royale des Sciences et Belles-Lettres de Berlin, ann. 1781.)

Thoughts on the Question, Why in our Disappointments we find Consolation in the Misfortune of Others? (*Nutz Beytrage zu den Neuen Strelitzischen Anzeigen.* Jan. 1782.)

Theses Physicæ. Basil. 1782.

Essai d'une Nouvelle Maniere d'Envisager les Differences, ou les Fluxions des Quantites Variables. (Mem. des Corresp. de l'Acad. Royale de Turin, ann. 1784 and 1785, Tom. I. p. 2.)

Observations made in a Tour from Vienna through Styermarck, the Ukrain and Friaul, 1785. (In John Bernoulli's Collection of Short Tours, Vol. XVI.)

Considerations Hydrostatiques. (Nova Acta Helvetica, Tom. I.)

Analytical Solutions respecting a Parachute attached to a Balloon. (*Leipz. Magaz. fur Reine u. Angew Marthe.* Part I. 1786.)

Sur

Sur le Mouvement Gyratoire d'un Corps attaché à un Fil extenſible. Premiere Memoire. (Nova Acta Acad. Sc. Imp. Petrop. Tom. I. pro anno 1783.)

Sur le Mouvement Gyratoire, &c. *Second Memoire.* (Nova Acta, Tom. II. 1784.)

Sur le Mouvement Gyratoire, &c. Troiſieme Memoire. (Nova Acta, Tom. III. 1785.)

Dilucidationes in Commentarium III. Euleri de Ictu Glandium contra Tabulam Exploſarum. (Nova Acta, Tom. IV. 1786.)

Eſſai ſur un nouvelle Machine Hydraulique propre à élever de l'Eau. (Ibid.)

Eſſai Theorique ſur les Vibrations des Plaques élaſtiques Rectangulaires et Libres. (Nova Acta, Tom. V. 1787.)

De Motu progreſſivo, rotatorio et oſcillatorio duorum Corporum Ope Fili ſuper Trochleam tranſeuntis connexorum. (Nova Acta, Tom. VI. 1788.)

De Motu et Reactione Aquæ per Tubos mobiles transfluentis. (Ibid.)

Mr. Bernoulli tranſlated alſo Merian's Philoſophical Memoirs (*Memoires de Philoſophie de M. Merian*) into German. 2 vols.

NEW PUBLICATIONS.

Nova Acta Acad. Scient. Imper. Petropolitanæ, &c. New Tranſactions of the Imperial Academy of Sciences at Peterſburgh. Vol. X. 1797. With 13 Plates.

OF the mathematical papers in this volume, moſt of which are by Leonard Euler, it is impoſſible to give any ſatiſfactory account in the limits allotted for this preſent article. Among the aſtronomical papers are:—On the Perturbation of the Motion of Saturn, by Schubert. The author has employed, but with some variation, the formula of De la Place in regard to the theory of Jupiter and Saturn. On the Variation of the Obliquity of the Ecliptic, and of the Tropical Year, by the same. Observations made in the Observatory of the Academic College at Mietau, from 1791 to 1795, by M. Beitler. Observations made in 1795 at his own house, by M. Inochodzow. Observations on a Solar Eclipse, by M. Kumowski. Extracts from Meteorological Observations made in 1768 and 1769, at Jakutsk, by J. Islenief. The greatest height of the barometer was 28·07 Paris inches, the least 26·17. On the 11th of December 1768, at 4 in the afternoon, the mercury of a De Lisle's thermometer, the scale of which reached only to 228° below boiling water*, sunk entirely into the bulb. About 8 o'clock on the 12th, the observer exposed to the open air another thermometer, the divisions of which reached down to 245°; and at 8 o'clock in the morning of the 15th, the quicksilver stood at 229° (62·8° Fahr. below 0°). Having moved the instrument, the quicksilver fell suddenly into the bulb, and remained in it till 8 o'clock in the morning of the 19th; but at noon it rose to 199° (26·8 of Fahr. below 0°). Extracts from Meteorological Observations made at Petersburgh in 1792. In the department of Physics we find C. F. Wolff's Tenth Dissertation, fourth part, on the Muscular Vessels of the Heart, illustrated with engravings. Method of purifying Corrupted Water, with new Experiments, by Lowitz. A little sulphuric acid and common salt, when the water is intended for the purposes of cookery, strengthens the effect of the charcoal powder. The same author gives an account of his having discovered Strontian earth in sulphat of barytes, in which, according to his numerous experiments, it forms a fifth part, and is always present. He explains the difference between it and cal-

* The scale of De Lisle's thermomerer commences with the point of boiling water. The freezing point is 150° below boiling. EDIT.

careous

careous earth and barytes chiefly by its union with acids, and gives directions for preparing the muriat of barytes for medical purposes. Three papers by B. Sewergin, on different species of talc, the Russian kinds of serpentine, and the cyanite. A Physical and Topographical Sketch of Tauria, by Professor Pallas; also a Description of some new Siberian Plants (with figures) from the Collection of the late J. Sievers of Hanover, viz. two species of robinia, the *jubata* and *tragacanthoides*; a species of sophera, *argentea*; tamarisks, *songarica*; roses, *berberifolia*; molucella, *diacanthophylla*; rhubarb, *leucorhizon*; and three kinds of ribes, *saxatilis*, *fragrans* and *tristis*. Herrman's Mineralogical Observations made during a Journey through the Chain of the Ural Mountains, which he traversed from West to East. J. T. Kölreuter on the true Organs of Fructification in the *Periploca Græca*. Professor Lepechin's Description of a new Siberian kind of *Polygonum*, which he calls *Laxman*, from the discoverer, and of which a figure is given. It has a large stem, and its flowers are furnished with eight stamina and three styles, placed in tender panicles at the angles of the leaves, which are lanceolated, of equal breadth, smooth, and sharp pointed.

Reise durch Pommern nach der Insel Rügen, &c. A Tour through Pomerania to the Isle of Rugen and a Part of the Duchy of Mecklenburg, in the Year 1795. In a Series of Letters, by John Frederic Zöllner. With Copper Plates. Berlin 1797, 8vo.

THE route which the author pursued, in this tour, was through Stettin, Wollin, Swinemünde, Wolgast, Greifswald, Stralsund, Hiddensü, Barth, Rostock, Dobran, Remplin, Strelitz, Ruppin, and thence to Berlin. The work, besides a descriptive account of the places which the author visited, contains also anecdotes of remarkable persons, and observations respecting trade, manufactures and natural history. In an Appendix is given a great many statistic observations relating to Pomerania, Rugen, Mecklenburg, &c. Tables of the exports and imports of Stettin in the year 1794; of the number (535) and value of the ſhips built in Swediſh Pomerania, between the years 1781 and 1795; and of the heights of the barometer on the 6th of Auguſt 1795, obſerved at Peterſburgh, Berlin, Halle, Breſlau, Rudolſtadt, Bayreuth, Seburg, the Brocken, St. Gothard, two eminences in Rugen, and at other places.

Voyage Pittoreſque de la Syrie, &c. Pictureſque Travels through Syria, Phenecia, Paleſtine and Lower Egypt. No. I. and II. Paris, 1798.

THIS work conſiſts of elegant engravings accompanied with proper deſcriptions. The plates in the firſt number are: 1. A view of the cenotaph of Caius Cæſar near Hems, formerly Edeſſa. 2. View of a part of the village of Cana in Galilee. 3. General view of Jeruſalem. 4 and 5. Sepulchral monument of the cities of Judah. 6. Fortune-tellers. Thoſe of the ſecond number are: 1. Gate of the Temple of the Sun at Palmyra. 2 and 3. Portico of Diocletian. 4. Beautiful view near Tripoli. 5. Entablature of the Temple of the Sun at Balbec. 6. Courſe of the Nahr Quades or Sacred River.

The whole work will be compriſed in three volumes folio, containing about 300 engravings beſides vignettes, and will make 50 or 55 numbers. The price of each number, to ſubſcribers, is 30 livres (25 ſhillings); to non-ſubſcribers 35 livres (about 29 ſhillings).

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

FRANCE.

SOCIETY OF HEALTH IN THE COMMUNE OF NANCY.

THE public fitting of this fociety on the 1ft of Frimaire, VII. Year, was opened by C. Lallemand, prefident, who read a difcourfe on the utility of medical correfpondence for preferving purity of principles in the art of healing, and on the moft advantageous method of teaching it.

C. Mandel, profeffor of therapeutics and pharmacy, read a differtation on iron. The author explained the different ftates in which it is found naturally; thofe which may be given to it by art; and the fervices which it has rendered to mankind by its magnetic properties, particularly in regard to the mariner's compafs, and its power of attracting lightning and conducting it to any place required. He demonftrated the affinity of this metal with oxygen, the caufe of its fo eafily uniting with faline fubftances, and of its fpeedy oxydation by air and water, and of its folution in the latter vehicle which it decompofes. He then proceeded to the action of iron on the animal economy, and took a view of the fpeedy cures which it effects; and the accidents, on the other hand, which it has occafioned to fome individuals, even when the dofe was weak. This led him to propofe the following very interefting queftion, Whether the iron which exifts materially and formally in our humours, and above all in the blood, might not be confidered, on account of its natural increafe and diminution, as the caufe of a great number of difeafes? And he mentioned chlorofis as one of thofe moft likely to conduct to a fatisfactory refult.

He mentioned the new fyftem (quoting Dr. Rollo), which holds that the greater or lefs quantity of oxygen in the blood is the caufe of various difeafes. Without denying this principle, he combated the application made of it by Dr. Rollo to certain difeafes, particularly chlorofis, which he imputes to a privation of oxygen; to reftore which, he recommends metallic oxyds as being proper to furnifh oxygen. C. Mandel afferts that this difeafe is deftroyed by medicines capable of carrying off oxygen, inftead of introducing it into the fyft m: that it is cured by iron which has undergone no other preparation than a great divifion of its parts; from which he concludes, that not difoxygenation, but rather *deferrugination*, ought to be affigned as the determining caufe.

The author next pointed out the different medical cafes in which iron, or preparations of it, ought to be adminiftered; and then examined the queftion whether the magnet ought to be admitted among the means of medical cure, or entirely rejected. He gave an account of the different fyftems of the partifans and antagonifts of this mineral: he combated from experience the opinion of the latter, and fhewed that there was nothing lefs doubtful than that the iron contained in the blood, though in a ftate of oxyd, cannot be attracted by the loadftone. In the laft place, he concluded, without admitting all the wonders afcribed to it, that this mineral ought to be retained among the curative means.

C. Salmon, profeffor of the materia medica, communicated two obfervations which tended to fupport the laft affertion.

C. Willemet, profeffor of botany, read fome fragments in regard to the natural and literary hiftory of feveral kinds of laurel—a plant held in great veneration by the ancients. This valuable tree was employed in all their religious ceremonies,

monies, had a ſhare in their myſteries, and was made the reward of valour, merit and virtue. Its medical properties were not forgotten. In ſpeaking of the laurel-cherry, (*prunus lauro-ceraſus*, L.) C. Willemet gave an account of the modern experiments made on the effects of the water diſtilled from it. He took a view alſo of the qualities and virtues of the common roſe-bay or oleander (*nerium oleander*, L.); the —— (*ruſcus hypogloſſum*, L.); and the laureſtine (*viburnum tinus*, L.)

ITALY.

The National Inſtitute of the Ligurian Republic was inſtalled on the 24th of Brumaire, 7th year, by the directory of that republic. It conſiſts of ſixty members, thirty-ſix of whom are reſident; and thirty-ſix aſſociates, inhabitants of the republic. They form two claſſes, each of which is ſubdivided into three ſections.

The firſt claſs is that of the Mathematical and Phyſical Sciences; the three ſections of which are: 1ſt, Agriculture, commerce and manufactures; 2d, The nautical ſcience, mathematics, phyſics and natural hiſtory; 3d, Chemiſtry, botany, anatomy, medicine and ſurgery.

The ſecond claſs comprehends Philoſophy, Literature, and the Fine Arts. Its ſections are as follows: 1ſt, The art of reaſoning; and analyſis of the operations of the human underſtanding, grammar, eloquence and poetry; 2d, Political ſciences, hiſtory and antiquities; 3d, The art of deſign.

ROYAL SOCIETY OF LONDON.

Since our laſt report, (Vol. II. p. 327) Papers on the following ſubjects have been read to the Society.

One on the methods of finding the latitude by double obſervations, which contained ſeveral curious calculations and uſeful tables. This paper, which occupied almoſt the whole of two evenings, is of ſuch a nature that our limits will not allow our giving any account of it.

A paper containing meteorological obſervations made at Conſtantinople, and ſome curious information reſpecting the plague which ſo often cauſes dreadful devaſtation in the Eaſtern countries. The remarks brought forward on this ſubject go to eſtabliſh the fact, that the infection is only caught by contact either of a diſeaſed perſon, or of articles that have been in contact with the infected.

A paper on the natural hiſtory of the elephant, by John Corſe, Eſq. author of the article on the ſame ſubject given in a preceding part of the preſent number of our work. This paper, which contains a great variety of curious information, excited much attention. His obſervations are the reſult of many years reſidence in India. By them it appears that the accounts of the ſagacity, modeſty and ſize of the elephant have been greatly exaggerated by natural hiſtorians. The female, when brought forth, is about 35 inches high; when full grown, from 7 to 8 feet. A full grown male is 8 or 9 feet high, meaſured at the ſhoulder as the height of a horſe is taken.

A paper on the decompoſition of the boracic acid, by M. Crell.

ANTIQUARIAN SOCIETY OF LONDON.

On Thurſday the 14th of Feburary, an Eolopile of great antiquity, made of braſs, and which had been dug up in making the Baſingſtock canal, was preſented to this Society by Mr. Fry the letter-founder. The form is ſingular: inſtead of being globular with a bent tube, it is in the form of a groteſque human figure. The blaſt comes from its mouth. The only thing ſimilar we have ever met with in this country is the eolopile called Jack of Hilton, mentioned in Plott's Hiſtory of Staffordſhire.

MISCEL-

MISCELLANEOUS.

ANTIQUITIES.

MEN of letters, artifts, and thofe fond of antiquities and numifmatics, had long regretted, that the rich collections of medals and gems in poffeffion of the royal family of Pruffia were fcattered and preferved in different places. The late king, who approved of a plan prefented to him for uniting all thefe collections in the capital, caufed to be brought thither, towards the clofe of his reign, and depofited in his own cabinet, the beautiful collection of ancient and modern medals, crown-pieces, &c. which the margraves had formed at Anfpach, and to which he made confiderable additions. To complete the execution of the above plan, it however ftill remained to add to the cabinet of Berlin the grand collection of ancient medals and gems preferved at Potfdam. This valuable collection, made by Frederick I. and defcribed by that celebrated antiquarian Beger*, was enriched afterwards by Frederick II. who purchafed the antique medals of Pfau, and the magnificent cabinet of gems of Baron de Hofch, almoft unique of its kind. This collection was brought to the capital in 1770, and placed by Frederick II. in the Temple of Antiques at *Sans Souci*, where it long ferved for the noble amufement of that great man, who was fond of being furrounded by mafter-pieces of every art, and by every fource of inftruction. His prefent majefty has lately gratified the wifhes of artifts and men of letters, by ordering, on a propofal made to him by the Directory of the Royal Academy of

* Laurence Beger, the fon of a tanner at Heidelberg, and born in 1653, was librarian to Frederic William, elector of Brandenburgh. He was member of the Academy of Berlin, and died there in 1705. He was efteemed by the Learned for his works, among which are: Thefaurus five Gemmæ, Numifmata, &c. 3 vol. fol. 1696 and 1701; Regum et Imperatorum Numifmata à Rubenio edita 1700, fol.; De Nummis Cretenfium Serpentiferis, 1702. fol. EDIT.

of Sciences, that this collection should be transferred to Berlin, and incorporated with his collection. The directory of the academy, in order to promote farther his majesty's views, and to complete the royal cabinet, have added to it two valuable collections belonging to the academy, viz. that of Lippert's * casts, and that of the bracteals, or coin of the middle ages, formed by Rau, and augmented by Mohsen †; so that the royal cabinet contains at present about 5400 engraved gems, 3000 casts by Lippert, 16000 antique medals, 5000 bracteals, with 5 or 6000 modern medals and crowns. Among the modern series, the richest is that of the medals and crowns of Prussia.

ANATOMY.

C. Cuvier, in the course of his researches respecting the anatomy of white-blooded animals, which he intends soon to publish, has found that the leech will oblige him to change the general denomination. He observed in that animal red blood, not that which it sucks, and which would be contained in the intestinal canal, where it is immediately altered, but a real nourishing fluid contained in the vessels, and circulating there by means of an alternate movement of the systole and the diastole. These vessels form four principal trunks, two of which are lateral, the third dorsal, and the last ventral. The two former are of an order different from that of the two latter; but the author has not yet been able to determine which are the arterial and which the venal.

* Philip Daniel Lippert, professor of antiquities in the Academy of the Fine Arts at Dresden. He was born at Meissen in 1702, and died on the 28th of March 1785. Among his works are Dactyliotheca, or, A Collection of the Engraved Stones of the Ancients, consisting of 200 impressions from the principal cabinets in Europe, for the use of the fine arts and artists. Leipsic, 1767. A Supplement to the Dactyliotheca, consisting of 1049 impressions. *Ibid.* EDIT.

† John Charles William Mohsen, member of the college of physicians, physician to his Prussian Majesty, and to the school of Noble Cadets at Berlin. EDIT.

venal. The two lateral veſſels proceed from one end of the body to the other, and are joined by branches which form a very beautiful tiſſue when injected. The ventral and dorſal veſſels do not form a tiſſue of the like kind. They only throw out branches diſpoſed alternately in an oblique direction, and ſubdivided in the uſual manner. The ſecond is placed exactly under the medullary cord of the ganglions, from which all the nerves proceed. It is impoſſible to open a leech without producing a great effuſion of that blood. Enough, however, remains in the veſſels to be diſtinguiſhed. Its colour is almoſt the ſame as that of the arterial blood of the frog.

NORTHERN GEOGRAPHY AND STATISTICS.

M. Hammer, conductor general of the dioceſe of Aggerhuus in Norway, who left all his property to the Royal Norwegian Academy of Sciences, endowed alſo a foundation, which has been confirmed by his Daniſh Majeſty, and in conſequence of which a part of the money bequeathed is to be laid out in printing his manuſcripts, and for purchaſing natural curioſities, the productions of Norway. Another part is to be employed in defraying the expence of travels through Norway, and the following diſtricts are in particular to be explored: Neiden, Powig, Peiſen, Nordfieldet, the White Sea, and Dvinaan, the moſt remarkable natural objects of which muſt be deſcribed. Theſe travels are to be conducted on the plan propoſed by Linnæus in the *Norwegian Houſehold Calendar*. All remarkable objects and antiquities are to be illuſtrated with maps and drawings, and the journals of the different travellers will be inſerted among the papers of the ſociety.

Baron Hermelin, counſellor of mines, one of the richeſt men in Sweden, is now employed in preparing maps of every province of that kingdom, which he means to publiſh at his own expence. He has already begun with Lapland and the northern diſtricts.

ASTRO-

ASTRONOMY.

On the evening of Frimaire 16th, C. Bouvard, aſtronomer belonging to the Obſervatory at Paris, diſcovered a comet in the conſtellation of Hercules. At half after ſix next morning, its right aſcenſion was 248½ degrees, and its northern declination 31½. It had advanced 43 minutes per hour towards the eaſt, and 28 towards the ſouth. It was ſmall and difficult to be ſeen. It forms the 89th, according to the catalogue, in De Lalande's Aſtronomy.

MANUFACTURES.

Michael Szekely, overſeer of mines to Count Schönborn at St. Nicholas, near Munkats in Hungary, has manufactured a kind of cloth from the ſwallow-wort (*aſclepias vincetoxicum*) interwoven with ſilk. A ſpecimen of this new production, conſiſting of 6¾ German ells, was preſented to the magiſtrates of Ofven for inſpection. The firſt manufacturing of it coſt about 7 or 8 ſhillings ſterling, but in future the ſame quantity will coſt only 3 or 4 ſhillings. It was two ells in breadth, and of conſiderable fineneſs.

ARTIFICIAL COLD.

Nearly at the ſame time that Meſſrs. Pepys and Allen were engaged in the intereſting experiments, of which we have given an account in the preceding pages, Mr. Walker of Oxford was alſo employed in producing frigorific mixtures. For this purpoſe, he uſed the ſame materials in the following proportions: 4 parts of the cryſtalliſed muriat of lime, pulveriſed, to 3 parts of uncompreſſed dry ſnow. On the 4th inſtant, having, by means of a previous mixture, reduced his materials to 40 below 0°, on mixing the cooled ingredients, they gave a temperature of – 63° or 95° below the freezing point of water. We believe the experiment was only on a ſmall ſcale. We have not learnt what ſubſtances, or whether any, were expoſed by Mr. Walker to the cold mixture.

MINERALOGY.

A lode * of silver, tolerably rich, has lately been discovered in the Hurland Mine, formerly called the Old Manor Mine, in Gwinear parish in the county of Cornwall, which they are now working, and which, judging from present appearances, we should expect would turn out of great national benefit, if we were not aware of the strong prejudices and great ignorance of the Cornish miners in general.

If we may credit the testimony of foreigners, the poorest mine in Cornwall is worked at a greater expence than the richest on the Continent. How can it be otherwise, while the present system, disgraceful to the age in which we live, is allowed to continue, without any attempts being made either to alter or improve it? We shall hardly be credited when we state that, in many places, the proprietors are never permitted to have a section of their mine: yet such is literally the fact. It would be incroaching upon the province of the *Captain of the Mine!* who is sole monarch of the subterranean legions, and guides all their operations.

From this man the owners must be content to receive the only accounts they can obtain of the state of their works; nor can they possibly help themselves, or interfere in the direction.

When it is known that this is the state of management, our readers, though they may regret the circumstance, will not be surprised to hear that the Wherry-mine near Penzance, one of the most curious in the world †, and in which we lately announced that cobalt had been found, has been discontinued working, and the shaft been closed up. Have we not reason to fear that this mine, so rich in tin and cobalt, has fallen a disgraceful sacrifice to the ignorance in the art of mining, which so shamefully prevails in this county? While science is excluded, what can be expected?

* The Cornish term for a vein or stratum.

† The mouth of the shaft was more than 600 feet from the shore, and surrounded by the sea.

The

The French Government have lately taken the state of the mines in France into their consideration, established a school of mineralogy under the auspices of the minister of the interior, and are now devising means for propagating instruction relative to that important branch of industry.—The state of the mines in this country calls loudly on our Government to endeavour to devise some mean of improvement. The loss that results to the community from the prevailing ignorance of the operative people employed in them is absolutely incalculable. How happy should we feel, if our well-meant hint should have the effect to make the matter be taken up by those who have influence sufficient to accomplish the object!

DEATH.

On the 26th of November last, of a nervous fever, Frederick Albrecht Charles Gren, Public Professor of Medicine, and Member of the Society of the Searchers into Nature at Halle. He was born on the 1st of May 1760, at Bernburg. His premature death is a great loss to Chemistry and Natural Philosophy. The *Journal der Physik*, or Journal of Natural Philosophy, begun in 1770, of which he was editor, is well known. Among his works are: Observations on Fermentation and the Products thence obtained, 8vo. Systematic Manual of Chemistry, 2 vols. 8vo. Principles of Natural Knowledge, 8vo. *Observationes et Experimenta circa Genesin Aëris fixi et phlogisticati*, 8vo. Principles of Pharmacology and the Materia Medica, 2 parts.—He was a contributor also to the *Allgemein-Literatur-Zeitung* of Jena, and author of various papers in Crell's Chemical Annals.

THE

PHILOSOPHICAL MAGAZINE.

MARCH 1799.

I. *Account of a remarkable Fiery Eruption from the Earth, in Iceland, in the Year* 1783. *By* S. M. Holm, S.S. Theol. Cand.

THE following account is taken from a ſmall work written by Mr. Holm, a clergyman, and publiſhed in the Daniſh language at Copenhagen, with two charts. The author ſays, in his preface, that he was born in the iſland in the year 1750, and lived there till the year 1774; that he had himſelf ſeen all the places mentioned in it, and had ſince kept up an uninterrupted epiſtolary correſpondence with his countrymen, from whom he received the particulars of the devaſtation occaſioned by this ſingular diſaſter.

On the 1ſt of June 1783, ſeveral violent ſhocks of an earthquake were felt in various parts of Iceland; and theſe ſhocks afterwards increaſed to ſuch a degree, that, on the 11th of the ſame month, the inhabitants were obliged to deſert their habitations and to live in the open air. About the ſame time ſmoke and vapour were ſeen to riſe alternately from the earth in the wild diſtricts towards the north, in the neighbourhood of Sidu, Landbrot, Medalland and

Alptaver. After this three columns of fire were obferved, the moft northern of which firft made its appearance. When firft feen, they flamed up feparately; but they afterwards united and rofe to fuch a height that they could be perceived at the diftance of thirty-four miles, when the flame was not covered by thick vapour.

Iceland is bordered by a long chain of mountains, which are all exceedingly high and always covered with fnow. The largeft and higheft of thefe is the Klofa-Jœkul, in which the principal and beft known rivers of the ifland formerly had their fources. Among thefe mountains there are alfo four volcanoes, the Skaptar-Jœkul, the Sula, Trœlladyngia, and the Oerœfa-Jœkul, the laft of which is the moft violent. They at firft throw out water, and then fire. There are feveral of the fame kind in the ifland; but the well known Hecla throws out only fire.

On the 8th of June the bright flames of the before-mentioned column could be clearly diftinguifhed. They were accompanied with a violent and inceffant eruption of fand, fulphureous duft, afhes, large pumice ftones, and moft dreadful explofions. A furious wind, which prevailed at the fame time, filled the atmofphere in fuch a manner with fand and fulphureous vapour, that people could not fee either to read or to write even at noon. The afhes and fcoriæ which fell back from the atmofphere were red hot. There fell at the fame time a kind of filth as black as ink, which feemed as it were hairy, having fometimes the appearance of fmall balls, and fometimes of wreaths or rings.

On the 11th the fiery column, which had vanifhed for a little, again made its appearance, and could be diftinctly feen at the diftance of thirty or forty miles. Its thundering noife could be heard at the fame diftance, and continued throughout the whole fummer. The above column was accompanied the fame day by a very violent rain, which occafioned infinite damage; becaufe the water, in many places, fwept off whole pieces of the foil and carried them with it into

into the deep gulphs. The water of this rain was at the ſame time ſo ſharp and acrid, on account of the many ſaline and ſulphureous particles which it contained, that it occaſioned ſevere pain in the hands and feet where it fell.

The places in the neighbourhood of this column were at the ſame time expoſed to violent cold, ſnow, and hail of an uncommon magnitude; but, as the column extended farther, theſe were ſucceeded by a ſcorching and almoſt unſufferable heat, and the ſun appeared like a red globe. This heat continued for ſeveral days without interruption, and returned ſeveral times in ſucceſſion. All thoſe places to which this deſtructive column extended were, by the ſhowers of ſtones and aſhes that accompanied it, deprived of all their graſs and every other plant; ſo that the inhabitants were reduced to great diſtreſs, and their cattle were frequently killed on the ſpot. In many places every vegetable production was as it were covered by a hard cruſt, from the continual ſulphureous evaporation.

When this fiery eruption firſt broke out, the river Skapta was ſwelled up in an uncommon manner, and a like overflowing was obſerved in ſeveral other rivers. On the 11th of June the Skapta ſuddenly diſappeared, and became totally dry in the courſe of twenty-four hours. Its bed was ſituated in a gulley called Skaptar-Gliufur, which extends four miles northwards through the higheſt rocks, and is above 200 fathoms deep. In this monſtrous gulley there aroſe, the ſecond day after the Skapta was dried up, a dreadful and undeſcribable fiery lake, which gradually increaſed till it overflowed the banks and filled all the neighbouring places whether high or low, the moſt exalted ſummits only excepted. Having inundated the farm of Buland, it covered not only the adjacent fields and hedges, but alſo the houſes and the church, though the farm is ſituated on a high rock. Towards the eaſt it extended ſix miles in breadth; its extent towards the weſt was alſo conſiderable; but towards the

the ſouth its progreſs had been checked by lofty mountains.

Thus ſwelled and towering up into huge waves it endeavoured on all ſides to procure a paſſage, which, by its continually preſſing forwards, it at length effected towards the ſouth in a valley between the mountains. Through this opening it ruſhed with incredible violence and force, like the moſt terrible cataract, into the plain on the ſouth, over which it rolled, amidſt ſtrong concuſſions of the earth and awful thunder and exploſions in the atmoſphere, carrying before it ſtones, rocks and ſmall eminences. This flaming lake boiled and foamed in a dreadful manner with melted ſtones, iron, and other ſubſtances capable of being liquefied; ſome of the ignited rocks and ſtones, as large as whales and houſes, were ſeen ſwimming on its ſurface, or driving up and down.

In the mean time ſmoke and vapour aroſe from the earth, both in the neighbourhood of this fiery lake and in the more remote diſtricts. All theſe appearances continued inceſſantly both day and night from the 12th of June till the 12th of Auguſt. The lake ſtill ſpread itſelf in the open plains, but with leſs impetuoſity than before. The boiling and foaming, however, continued until it at length began to ſettle, and to form itſelf into a ſolid body. In many places it was found to have been 70, and in others 140 fathoms in depth. When it threw itſelf with violence into the bed of any river, the water which it diſplaced overflowed all the adjacent lands, and ſtill added to the devaſtation and diſtreſs it occaſioned. Seventeen farms were burnt by the fiery ſtream, and four ſwept entirely away by the water, beſides a great many others which were deſtroyed by lightning and the large ſtones that fell from the atmoſphere; ſo that their inhabitants were reduced to poverty, and obliged to wander about begging for relief. Three large rivers, the before-mentioned Skapta, the Hlverfisfliot, and the Steinſ-

myrarfliot,

myrarfliot, befides eight fmaller ones, were found entirely dried up.

On the 16th of Auguft the fiery lake began to ceafe fpreading farther. Wherever it proceeded it had burnt and deftroyed houfes, churches, villages, fields, meadows and forefts. Among the places deftroyed were many abounding with excellent herbs, fuch as the *clymus arenarius*, and medicinal plants; the want of which was a great and irreparable lofs to the ifland.

This fiery eruption, however, did not yet ceafe, but continued to rage with fury till October in the middle parts of the ifland, where vapour, flames, thunder and concuffions of the earth were in fucceffion obferved among the cold and extenfive mountains. In the firft half of November little change had taken place; but the flames began gradually to burn up with more brightnefs, which was confidered as a fign that the inflammable matter was now nearly exhaufted, and that the flame would be extinguifhed; efpecially as it had before affumed a variety of colours, fuch as green, blue and the like, according to the difference of the fubftances by which it had been nourifhed.

When the eruption firft took place, the whole atmofphere of the ifland was fo filled with fmoke, vapour and duft, that the fun had entirely a red appearance. In the neighbourhood of the mountains it was perfectly dark at noon; and the cold in the night time, confidering the warmth of the feafon, was very fenfible. Where the atmofphere was dry, the fire made the air highly oppreffive; but where moift, fuch fevere winter cold was produced in it, that the grafs, plants, and cattle were almoft deftroyed. The cows gave fcarcely an eighth part of the ufual quantity of milk; and a four-year-old wether, which before would have had ten pounds of fat, had now only two, and was fo weak as to be fcarcely able to ftand.

The afhes, fulphur and rain which fell from the heavens, were fo peftilential that they feemed to penetrate the very

 bodies

bodies of the cattle. Their hoofs became white; their hair fell off; and they were covered all over with puſtules and ulcers. The meadows alſo ſuffered ſeverely; and the cattle which had endeavoured to pick up the few ſcanty remains of graſs that had been left, might be ſeen lying dead on them in heaps. Many others were deſtroyed by hunger; and it was only a few that were ſaved by the means of hay. The cattle in general were ſo ſtunned, ſometimes by the dreadful exploſions of the thunder, and the inceſſant roaring and fire in the atmoſphere, that they ran into marſhy places, threw themſelves over precipices, or even ruſhed into the flames.

Theſe uncommon phenomena were no leſs deſtructive to the inhabitants. Many, in particular old people, and thoſe whoſe lungs were weak, could with difficulty breathe on account of the ſulphureous ſtench and vapour proceeding from the flames. Many alſo who enjoyed good health were reduced to a ſtate of illneſs; and many would have been ſuffocated had not moderate ſhowers of rain, which fell ſometimes, cooled and refreſhed the atmoſphere.

Beſides theſe circumſtances which took place in Iceland, many other phenomena worthy of notice occurred in the neighbourhood. A new iſland was thrown up in a part of the ſea where, according to the account of experienced ſea-men, the water before had been about a hundred fathoms in depth. Its diſtance from Iceland was ſixteen, and from Bird Iſland eight miles. In the month of Auguſt it threw up bright flames; and it continued to burn till February 1784. Later accounts ſtate that towards the end of the year it threw up a large column of fire intermixed with ſand. This iſland was about half a mile in circumference, and its height appeared to be equal to that of the mountain Eſian.

Towards the north-weſt, nearer to Iceland than the old eaſtern gulph of Greenland, lies another very high iſland, larger than the former; which, according to the lateſt accounts, has for a long time burnt day and night. We have been informed alſo by accounts from Iceland and Norway, that a violent fiery eruption took place in the moſt diſtant wilds of Greenland, oppoſite to the northern part of Iceland; and alſo in other places, previous to that of the latter above deſcribed. This is confirmed by letters dated September the 14th, in which it is ſaid that a violent north wind from the ſea had brought over to the northern coaſt of Iceland abundance of aſhes, with a ſtrong ſulphureous ſmell; and this phenomenon continued the whole ſummer.

The effects of theſe remarkable phenomena ſeem to have extended alſo to other countries. At the time when the before mentioned acrid rain prevailed in Iceland, an uncommonly ſharp and penetrating rain of the like kind fell at Drontheim and other parts of Norway. In the Feroe iſlands this rain burnt as it were the leaves of the trees, and the graſs on the fields had a blackiſh appearance. When the wind blew from the N.W. great quantities of aſhes, ſand and ſulphureous vapour fell in theſe iſlands, though they are eighty miles diſtant from Iceland; and the ſails and decks of ſeveral ſhips, while on their paſſage between Copenhagen and Iceland, were covered with black ſandy duſt. Even in Zealand and at Copenhagen the ſun, from the beginning of June till the 8th of Auguſt, ſeemed remarkably red; and throughout the whole month of July the atmoſphere was ſo filled with duſt and vapour, that the ſun could not be ſeen in the evening after eight or nine o'clock. Even at noon the ſun was red, and this was obſerved in the night-time to be the caſe with the moon and the ſtars. The learned Profeſſor Kratzenſtein ſaid that theſe phenomena muſt proceed from a fiery eruption in Iceland; which was the more remarkable as Iceland lies at the diſtance of almoſt 300 miles from Copenhagen, towards the north-weſt. Others ſaid they aroſe from the great heats which frequently happened, and particularly on the 27th and 29th of July, and the 5th of Auguſt. The earth at this time was almoſt incapable of producing either herbs or graſs, and the leaves even withered on the trees. A whitiſh grey kind of duſt was ſeen to fall towards the ground; and the fields in the night were often overſpread with a blueiſh miſt, which was accompanied with a certain pale fiery brightneſs and a ſulphureous ſmell. During the nights when this fog prevailed, little or no dew fell. Phenomena of the ſame kind were obſerved in Germany, Holland, and other countries.

II. *An Account of* TOALDO'*s Syſtem reſpecting the Probability of a Change of Weather at the different Changes of the Moon. From* Journal des Sciences Utiles.

WERE the ſun the only cauſe of the variations of the weather, the regular courſe of that luminary, from year to year, would produce the ſame weather in the ſame ſeaſons. The principal variations of the weather, however, depend upon ſome other cauſe not ſo uniform, the diſcovery of which has long given employment to philoſophers; and as we find that the motion of the ſea ſeems to have an intimate connection with the motion of the moon, it has thence been believed, that the latter acts a principal part, not only in this phenomenon of the flux and reflux, but that it could not produce theſe variations on the earth, without having, at the ſame time, a conſiderable influence on the atmoſphere. The difference of the fluids which compoſe it, and, above all, the great elaſticity of the air, can alter this effect, but not entirely deſtroy it.

It is well known that no philoſopher has yet been able, from mere theory, to form any proper concluſion reſpecting theſe variations of the weather. To ſupply this deficiency, M. Toaldo called in the aid of experience, and compared the ſtate of the atmoſphere with the ſituation of the moon, where its activity appeared to be ſtrongeſt and weakeſt.

From

From obfervations made at Padua on this fubject, during the courfe of fifty years, he at length found that good and bad weather have been always determined by certain fituations of the moon; and this circumftance furnifhed him the means of foretelling, with fome degree of certainty, the ftate of the atmofphere by the fituation of that luminary deduced from aftronomical calculations. He diftinguifhes ten fituations of the moon, each of which is capable of producing a fenfible effect on our atmofphere; and, in order to comprehend thefe, it muft be obferved, that the motion of the moon has three different relations, from which there arife the fame number of revolutions, and that each of thefe has a particular duration, and at the fame time certain fituations, as expreffed in the following table:

REVOLUTIONS.	SITUATIONS OF THE MOON.
1. *Synodical*, in regard to the fun; continues 29 days 12 hours 44 minutes.	New moon Firft quarter Full moon Laft quarter
2. *Anomaliftic*, in regard to the moon's courfe; continues 27 days 13 hours 43 minutes.	Apogeum Perigeum
3. *Periodical*, in regard to the moon's paffing the equator; continues 27 days 7 hours 43 minutes.	Afcending equinoxes * Northern luniftices † Defcending equinoxes Southern luniftices

* The two paffages of the moon over the equator are called by M. Toaldo, one the *afcending*, and the other the *defcending equinox*. EDIT.

† The two *luniftices*, as M. de la Lande has called them, are: 1ft, the *oreal luniftice*, when the moon approaches as near as fhe can in each lunation to our zenith: 2d, the *auftral luniftice*, when fhe is at the greateft diftance from it. EDIT.

The

The ſituations of the moon which have a relation to the ſynodical revolution, are well known. It may, however, be remarked, that new and full moon are called the ſyzigies, and the firſt and laſt quarter the quadratures. The perigeum and apogeum are comprehended under the term apſides.

On account of the difference in the periods of theſe three revolutions, the ſituations of the moon do not return in the ſame order, till after a long ſeries of years; and in the difference of their coincidence, connected with the regular effect of the ſun at each ſeaſon, lies the cauſe of the different variations of the weather. The following are the rules which M. Toaldo has deduced from his obſervations.

The probabilities that the weather will change at a certain period of the moon are in the following proportions:

New moon - - -	6 : 1
Firſt quarter - - -	5 : 2
Full moon - - -	5 : 2
Laſt quarter - - -	5 : 4
Perigeum - - -	7 : 1
Apogeum - - -	4 : 1
Aſcending equinox - - -	13 : 4
Northern luniſtice - -	11 : 4
Deſcending equinox - -	11 : 4
Southern luniſtice - -	3 : 1

That is to ſay, a perſon may bet ſix to one, that the new moon will bring with it a change of weather. Each ſituation of the moon alters that ſtate of the atmoſphere which has been occaſioned by the preceding one; and it ſeldom happens that any change in the weather takes place without a change in the lunar ſituations. Theſe ſituations are combined, on account of the inequality of their revolutions, and the greateſt effect is produced by the union of the ſyzigies with the apſides. The proportions of their power to produce variations are as follows;

New

New moon	coinciding with the perigeum	-	33 : 1
Ditto	with the apogeum	-	7 : 1
Full moon . . .	with the perigeum	-	10 : 1
Ditto	with the apogeum	-	8 : 1

The combination of theſe ſituations generally occaſions ſtorms and tempeſts; and this perturbing power will always have the greater effect, the nearer theſe combined ſituations are to the moon's paſſage over the equator, particularly in the months of March and September. At the new and full moons, in the months of March and September, and even at the ſolſtices, eſpecially the winter ſolſtice, the atmoſphere aſſumes a certain character, by which it is diſtinguiſhed for three, and, ſometimes, ſix months. The new moons which produce no change in the weather, are thoſe that happen at a diſtance from the apſides.

As it is perfectly true that each ſituation of the moon alters that ſtate of the atmoſphere which has been produced by another, it is however obſerved that many ſituations of the moon are favourable to good and others to bad weather. Thoſe belonging to the latter claſs are: the perigeum, new and full moon, paſſage of the equator, and the northern luniſtice. Thoſe belonging to the former are: the apogeum, quadratures, and the ſouthern luniſtice. Changes of the weather ſeldom take place on the very days of the moon's ſituations, but either precede or follow them. It has been found by obſervation, that the changes effected by the lunar ſituations in the ſix winter months precede, and in the ſix ſummer months follow them.

Beſides the lunar ſituations to which the above obſervations refer, attention muſt be paid alſo to the fourth day before new and full moon, which are called the octants. At theſe times the weather is inclined to changes; and it may be eaſily ſeen, that theſe will follow at the next lunar ſituation. Virgil calls this fourth day a very ſure prophet. If on that day the horns of the moon are clear and well defined,

good

good weather may be expected; but if they are dull, and not clearly marked on the edges, it is a ſign that bad weather will enſue. When the weather remains unchanged on the fourth, fifth and ſixth day of the moon, we may conjecture that it will continue ſo till full moon, even ſometimes till the next new moon; and in that caſe the lunar ſituations have only a very weak effect. Many obſervers of nature have alſo remarked, that the approach of the lunar ſituations is ſomewhat critical for the ſick.

Conjectures on the Periods of Rain.

The riſing and ſetting of the moon, as well as its ſuperior and inferior paſſage of the meridian, may ſerve as a rule for foretelling the times of rain. M. Toaldo calls theſe ſituations the moon's angles.

The times moſt expoſed to rain are the riſing and ſetting; thoſe moſt favourable to good weather, the paſſage of the meridian. It has been remarked that, during rainy days, bad weather is always a little interrupted about the time when the moon paſſes the meridian. We muſt, however, make an exception to this rule as often as the angle of the moon does not coincide with that of the ſun. As theſe obſervations may be very eaſily made, by means of aſtronomical tables, in which the angles of the moon and ſun are marked, they are exceedingly well calculated to prove the truth of this ſyſtem. No one, for inſtance, will refuſe aſſent to it, when the daily changes correſpond with the angles of the moon; and when, independently of the effects of the moon's ſituation, the horizontal effect of the moon at riſing and ſetting is different from that produced by its paſſage over the meridian.

It rains oftener in the day time than in the night, and oftener in the evening than in the morning.

Influence of the Moon in regard to extraordinary Years.

Bad years take place when the apſides of the moon fall in the

the four cardinal points of the zodiac. Their intervals, therefore, are as 4 to 5, 8 to 9, &c. or as the intervals of the paſſage of the apſides through the four cardinal points of the zodiac. Thus the year 1777 was, in general, a bad year; and in that year the apſides of the moon were in the equinoctial ſigns; and it is probable that the years in which the apſides fall in the ſigns Taurus, Leo, Virgo and Aquarius, will be good and moderate years, as the year 1776 really was; and in that year the apſides of the moon were in Taurus and Virgo.

Every eighteenth year muſt be ſimilar. We, however, can not depend upon a return altogether the ſame, on account of the three different revolutions of the moon; and therefore it may happen, that the epoch of this extraordinary year may be retarded a year or perhaps two. Though approximations only are here given, this does not prevent their being uſeful to farmers, if they only pay attention to circumſtances. Beſides, various exceptions muſt be made for different parts of the earth; and it is difficult to determine theſe beforehand, as what regards this ſyſtem is applicable to the whole globe; but when the reſult of the ſyſtem has been improved by local obſervations, the conjectures for each country will be attended with more certainty.

The fifty-fourth year muſt have a greater ſimilarity to the firſt than to all the reſt; becauſe, at this period, the ſituations of the moon, in regard to the ſun and the earth, are again found in the ſame points.

The quantity of the rain which falls in nine ſucceſſive years is almoſt equal to that which falls in the next following nine. But this is not the caſe when we compare in like manner the quantity of rain which falls in ſix, eight or ten years.

Effects of the Moon on the Barometer.

The variations of the barometer are ſo intimately connected with changes of the weather, that there is reaſon to ſuppoſe that the moon has ſome influence on the ſtate of that inſtrument.

ment. For the ſake of more certainty, however, M. Toaldo compared a diary of the ſtate of the barometer, kept for many years, with the ſituations of the moon, and found the following reſult: 1ſt, That the barometer at the time of the moon's apogeum riſes the ſixth part of a line higher than at the perigeum; 2d, that at the time of the quadratures it ſtands a tenth of a line higher than at the time of the ſyzigies; and 3d, that it is a fourth of a line higher at the ſouthern luniſtice than the northern.

Thus far the compariſon of the moon's ſituations with the ſtate of the barometer agrees perfectly with meteorological obſervations. This, however, is not the caſe at the time of the moon's paſſage through her equinoctial points; for the heights of the barometer are then greater, chiefly when ſhe paſſes in Libra: a circumſtance which is contrary to meteorological obſervations, ſince theſe ſituations of the moon indicate bad weather. It muſt, however, be remarked, that in this contradiction the indications of the moon's ſituations are more to be depended on than thoſe of the barometer.

It has a like connection with the coincidence of the equinoctial point and the perigeum, which alſo gives heights conſiderably greater. The union of theſe points, however, is a ſign of great irregularity. It muſt here be remarked that, according to De Luc, the rapid movement of the barometer indicates a ſtorm of ſhort duration, and that in ſuch a caſe, even when it riſes, bad weather is likely to follow.

M. Toaldo ſays, that the Europeans, when they firſt viſited Mexico, found a ſingular cuſtom prevalent in that country. When a new emperor was choſen, he was obliged to ſwear that, during his government, rain ſhould fall according to the pleaſure of his ſubjects; that no inundations ſhould be occaſioned, and that the fields ſhould not be rendered unfruitful, &c. The multitude imagine that the meteorologiſt enters into an obligation of the like kind; but all that can be expected from him is confined merely to conjectural rules reſpecting changes of the weather; and even theſe

prognoſtics,

prognostics, when determined for particular places, must not be considered as free from frequent error, as those causes which act upon the earth, in general, may be much changed by local causes in different districts.

III. *On the present State of Surgery in Turkey. From* A Survey of the Turkish Empire. *By* W. ETON, *Esq.*

IT might reasonably be expected that a nation of warriors should have expert surgeons at least, and that they should have paid attention to the improvements and discoveries made by other nations. Nothing of this, however, is the case. They perform no operations, nor will they consent to an European's making an amputation, though the loss of life be a certain consequence of omitting it. Their art is simply confined to healing, and at most extracting a ball and a splinter of a bone. It must be confessed that, as their habit of body is generally healthy, nature performs often wonderful cures. They rely much on balsams, mummy, &c. There is in Constantinople a Persian extraordinary expert in the art of healing. The Arabs bury a person, who has received a wound in his body, up to the neck in hot sand for twenty-four hours; and apply with success the actual cautery for the dropsy.

I saw in the eastern parts of the empire a method of setting bones practised, which appears to me worthy of the attention of surgeons in Europe. It is by inclosing the broken limb, after the bones are put in their places, in a case of plaster of Paris (or gypsum) which takes exactly the form of the limb, without any pressure, and in a few minutes the mass is solid and strong. If it be a compound fracture, the place where the wound is, and out of which an exfoliated bone is to come, may be left uncovered, without any injury to the strength of the plaster encasement. This substance may be easily cut with a knife, and removed, and replaced

with

with another. If, when the fwelling fubfides, the cavity is too large for the limb, a hole or holes being left, liquid gypfum plafter may be poured in, which will perfectly fill up the void, and exactly fit the limb. A hole may be made at firft by placing an oiled cork or bit of wood againft any part where it is required; and when the plafter is fet, it is to be removed. There is nothing in gypfum injurious, if it be free from lime; it will foon become very dry and light, and the limb may be bathed with fpirits, which will penetrate through the covering. Spirits may be ufed inftead of water, or mixed with it (or vinegar) at the firft making of the plafter.

I faw a cafe of a moft terrible compound fracture of the leg and thigh, by the fall of a cannon, cured in this manner. The perfon was feated on the ground, and the plafter cafe extended from below his heel to the upper part of his thigh, whence a bandage, faftened into the plafter, went round his body. He reclined back when he flept, as he could not lie down. During the cure, where they faw matter or moifture appear through the plafter coating, they cut a hole with a knife to drefs the wound, or let out the matter more freely.

On this occafion I cannot help mentioning the treatment of parts frozen in Ruffia, not by the furgeons, but by the common people, the fuccefs of which I was an eye-witnefs to in feveral cafes, as well as to the failure of the common mode of treating frozen parts by the moft able furgeons of the army. I fhall fimply ftate the facts I relate to.

After Ochakof was taken, I received into my fubterranean lodging as many prifoners as it would contain, all of whom were either wounded or had a limb frozen. Among them were two children, one about fix and the other about fourteen years of age; the latter had one of her feet frozen to the ancle, the other all the toes and the fole of one of her feet. The fecond day the parts appeared black, (the firft day they were not much obferved.) The French furgeon,

 whom

whom Prince Potemkin had ſent for purpoſely from Paris, and who was a man of note, ordered them to be conſtantly bathed with warm camphorated ſpirits: the elder was removed to the hoſpital, when a mortification began; the younger I kept, and as we removed into winter quarters, I carried the child along with me. The mortified parts ſeparated, the bones of the toes came off, and, after a conſiderable time, the ſores healed. I ſhould have ſaid, the ſurgeon was for immediately amputating both the limbs.

In a ſubterranean room, not far from mine, were ſeveral women whoſe feet had been in a like manner frozen; but as no ſurgeon attended them, the Ruſſian ſoldiers and waggoners undertook the cure. It was alſo the ſecond day when they applied their remedy, and the parts were perfectly black. This remedy was gooſe-greaſe, with which the parts were ſmeared warm, and the operation often repeated: their directions were, never to let the parts be dry, but always covered with greaſe. The conſequence was, that by degrees the circulation extended lower down, and the blackneſs decreaſed, till, laſt of all, the toes were only diſcoloured, and at length circulation was reſtored to them.

I can account for this no otherwiſe, than that the fat kept the pores ſhut, and prevented the air from promoting putrefaction; in the meantime the veſſels were continually abſorbing part of the ſtagnated blood, till by degrees the whole circulation was reſtored. It is known that extravaſated and ſtagnated blood will remain a long time in the body without putrifying, if it be not expoſed to the air. I conclude alſo, that in theſe caſes of froſt, the mortification firſt begins on the ſurface, which is in contact with the air.

I only meant, however, to relate facts, and leave it to others to account for them.

This is a general practice of the peaſants throughout all Ruſſia; but if a part is diſcovered to be frozen, *before the perſon comes into a warm room*, the froſt may be extracted by plunging the part into cold water, or rubbing it with ſnow till the circulation returns.

IV. *Account of the Method of Catching Wild Elephants at Tipura in the East Indies. By* John Corse, Esq. *From* The Asiatic Researches.

[Concluded from page 12.]

HAVING now related, partly from my own knowledge, and partly from comparing the accounts given by different people employed in this business, the manner in which the male elephants, called Goondahs, are secured; I shall next, entirely from my own knowledge, describe the methods I have seen employed for securing a herd of wild elephants. Female elephants are never taken singly, but always in the herd, which consists of young and old of both sexes. This noble, docile, and useful animal, seems naturally of a social disposition, as a herd in general consists of from about 40 to 100, and is conducted under the direction of one of the oldest and largest females, called the Palmai, and one of the largest males. When a herd is discovered, about 500 people are employed to surround it, who divide themselves into small parties, called Chokeys, consisting generally of one Mahote and two Coolies, at the distance of twenty or thirty yards from each other, and form an irregular circle in which the elephants are inclosed: each party lights a fire and clears a foot-path to the station that is next him, by which a regular communication is soon formed through the whole circumference from one to the other. By this path reinforcements can immediately be brought to any place where an alarm is given; and it is also necessary for the superintendants, who are always going round to see that the people are alert upon their posts. The first circle (the Dawkee) being thus formed, the remaining part of the day and night is spent in keeping watch by turns, or in cooking for themselves and companions. Early next morning one man is detached from each station, to form another circle in that direction where they wish the elephants to advance. When it is finiſhed, the people ſtationed neareſt to the new circle put out their fires and file off to the right and left, to form the advanced party, thus leaving an opening for the herd to advance through; and by this movement, both the old and new circle are joined and form an oblong. The people from behind now begin ſhouting and making a noiſe with their rattles, tomtoms, &c. to cauſe the elephants to advance; and as ſoon as they are got within the new circle, the people cloſe up, take their proper ſtations, and paſs the remaining part of the day and night as before. In the morning the ſame proceſs is repeated; and in this manner the herd advances ſlowly in that direction where they find themſelves leaſt incommoded by the noiſe and clamour of the hunters, feeding, as they go along, upon branches of trees, leaves of bamboos, &c. which come in their way. If they ſuſpected any ſnare, they could eaſily break through the circle; but this inoffenſive animal, going merely in queſt of food, and not ſeeing any of the people who ſurround him, and who are concealed by the thick jungle, advances without ſuſpicion, and appears only to avoid being peſtered by their noiſe and din. As fire is the thing elephants ſeem moſt afraid of in their wild ſtate, and will ſeldom venture near it, the hunters always have a number of fires lighted, and particularly at night, to prevent the elephants coming too near, as well as to cook their victuals and keep them warm. The ſentinels ſupply theſe fires with fuel, eſpecially green bamboos, which are generally at hand, and which, by the crackling and loud report they make, together with the noiſe of the watchmen, deter the elephants from coming near; ſo that the herd generally remains at a diſtance near the centre of the circle. Should they at any time advance, the alarm is given, and all the people immediately make a noiſe and uſe their rattles to make them keep at a greater diſtance. In this manner they are gradually brought to the Keddah, or place where they are to be ſecured. As the natives are extremely ſlow in their operations, they ſeldom bring the herd above one circle in a day, except on an emergency, when they exert themſelves and advance two circles. They have no tents or covering but the thick woods, which, during the day, keep off the rays of the ſun; and at night they ſleep by the fires they have lighted, upon mats ſpread on the ground, wrapt up in a piece of coarſe cloth. The ſeaſon is then ſo mild that the people continue very healthy; and an accident ſeldom happens except to ſtragglers about the outſkirts of the wood, who are ſometimes, though very rarely, carried off by tigers. The Keddah, or place where the herd is to be ſecured, is differently conſtructed in different places; here it conſiſts of three encloſures, communicating with each other by means of narrow openings or gateways. The outer encloſure, or the one next to the place where the elephants are to enter, is the largeſt; the middle one is generally, though not always, the next in ſize; and the third, or furthermoſt, is the ſmalleſt. Theſe proportions, however, are not always adhered to in the making of a Keddah, nor indeed does there appear to me any reaſon for making three encloſures: but as my intentions are merely to relate facts, I ſhall proceed to obſerve, that when in the third or laſt encloſure, the elephants are then only deemed ſecure; here they are kept ſix or eight days, and are regularly though ſcantily fed from a ſcaffold on the outſide, cloſe to the entrance of an outlet called the Roomee, which is about ſixty feet long and very narrow, and through which the elephants are to be taken out one by one. In many places this mode is not adopted; for, as ſoon as the herd has been ſurrounded by a ſtrong paliſade, Koomkees are ſent in with proper people, who tie them on the ſpot, in the ſame manner as was mentioned above of the Goondahs, or male elephants, that are taken ſingly. Theſe encloſures are all pretty ſtrong; but the third is the ſtrongeſt, nor are the elephants deemed ſecure, as already obſerved, till they have entered it. This encloſure has, like the other two, a pretty deep ditch on the inſide; and, upon the

the bank of earth, that is thrown up from the excavation, a row of ſtrong paliſades of middle-ſized trees is planted, ſtrengthened with croſs bars, which are tied to them about the diſtance of fourteen inches from each other; and theſe are ſupported on the outſide by ſtrong poſts like buttreſſes, having one end ſunk in the earth and the other preſſing againſt the croſs bars to which they are faſtened. When the herd is brought near to the firſt encloſure, or Baigcote, which has two gateways towards the jungle, from which the elephants are to advance, (theſe, as well as the other gateways, are diſguiſed with branches of trees and bamboos ſtuck in the ground ſo as to give them the appearance of a natural jungle,) the greateſt difficulty is to get the herd to enter the firſt or outer encloſure; for, notwithſtanding the precautions taken to diſguiſe both the entries as well as the paliſade which ſurrounds this encloſure, the Palmai, or leader, now appears to ſuſpect ſome ſnare, from the difficulty and heſitation with which in general ſhe paſſes into it; but, as ſoon as ſhe enters, the whole herd implicitly follows. Immediately, when they are all paſſed the gateway, fires are lighted round the greateſt part of the encloſure, and particularly at the entries, to prevent the elephants from returning. The hunters from without then make a terrible noiſe by ſhouting, beating of tomtoms (a kind of drum), firing blunt cartridges, &c. to urge the herd on to the next encloſure. The elephants, finding themſelves enſnared, ſcream and make a noiſe; but, ſeeing no opening except the entrance to the next encloſure, and which they at firſt generally avoid, they return to the place through which they lately paſſed, thinking perhaps to eſcape, but now find it ſtrongly barricaded; and as there is no ditch at this place, the hunters, to prevent their coming near and forcing their way, keep a line of fire conſtantly burning all along where the ditch is interrupted, and ſupply it with fuel from the top of the paliſade; and the people from without make a noiſe, ſhouting and hallooing, to drive them away. Whenever they turn, they find themſelves oppoſed by burning fires, or bundles of reeds and dried graſs, which are thruſt through the opening of the paliſades, except towards the entrance of the ſecond encloſure, or Doobraze-cote. After traverſing the Baigcote for ſome time, and finding no chance of eſcaping but through the gateway into the next encloſure, the leader enters, and the reſt follow: the gate is inſtantly ſhut by people who are ſtationed on a ſmall ſcaffold immediately above it, and ſtrongly barricaded, fires are lighted, and the ſame diſcordant din made and continued, till the herd has paſſed through another gateway into the laſt encloſure, or Rajecote, the gate of which is ſecured in the ſame manner as the former was. The elephants, being now completely ſurrounded on all ſides, and perceiving no outlet through which they can eſcape, appear deſperate, and in their fury advance frequently to the ditch in order to break down the paliſade, inflating their trunks, ſcreaming louder and ſhriller than any trumpet, ſometimes grumbling like the hollow murmur of diſtant thunder; but wherever they make an attack, they are oppoſed by lighted fires, and by the noiſe and triumphant ſhouts of the hunters. As they muſt remain ſome time in this encloſure, care is always taken to have part of the ditch filled with water, which is ſupplied by a ſmall ſtream, either natural, or conducted through an artificial channel from ſome neighbouring reſervoir. The elephants have recourſe to this water to quench their thirſt and cool themſelves after their fatigues, by ſucking the water into their trunks, and then ſquirting it over every part of their bodies. While they remain in this encloſure, they continue ſulky, and ſeem to meditate their eſcape; but the hunters build huts, and form an encampment as it were around them, cloſe to the paliſade; watchmen are placed, and every precaution uſed to prevent their breaking through. This they would ſoon effect, if left to themſelves, notwithſtanding the

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palifade is made of very ftrong ftakes funk into the earth on the outfide of the ditch, and ftrengthened by crofs bars and buttreffes as already mentioned.

When the herd has continued a few days in the Keddah, the door of the Roomee is opened, into which fome one of the elephants is enticed to enter, by having food thrown firft before, and then gradually further on into the paffage, till the elephant has advanced far enough to admit of the gate's being fhut. Above this wicker-gate, or door, two men are ftationed on a fmall fcaffold, who throw down the food. When the elephant has paffed beyond the door, they give the fignal to a man who from without fhuts it by pulling a ftring, and they fecure it by throwing two bars that ftood perpendicular on each fide, the one acrofs the other thus ×, forming the figure of St. Andrew's Crofs; and then two fimilar bars are thrown acrofs each other behind the door next to the Keddah, fo that the door is in the centre: for farther fecurity, horizontal bars are pufhed acrofs the Roomee, through the openings of the palifades, both before and behind thofe croffes, to prevent the poffibility of the door's being broken. The Roomee is fo narrow that a large elephant cannot turn in it; but as foon as he hears the noife that is made in fhutting the gate, he retreats backwards, and endeavours to force it: being now fecured in the manner already noticed, his efforts are unavailing. Finding his retreat thus cut off, he advances and exerts his utmoft force to break down the bars, which were previoufly put acrofs a little farther on in the outlet, by running againft them, fcreaming and roaring, and battering them, like a ram, by repeated blows of his head, retreating and advancing with the utmoft fury. In his rage he rifes and leaps upon the bars with his fore-feet, and ftrives to break them down with his huge weight. In February 1788 a large female elephant dropt down dead in the Roomee, from the violent exertions fhe made. When the elephant is fomewhat fatigued by these exertions, strong ropes * with running nooses are placed in the outlet by the hunters; and as soon as he puts a foot within the noose, it is immediately drawn tight and fastened to the palisades. When all his feet have been made pretty fast, two men place themselves behind some bars that run across the Roomee to prevent his kicking them, and with great caution tie his hind-legs together, by passing a cord alternately from the one to the other, like the figure 8, and then fastening these turns as above described. After this the Pharah, Dools, &c. are put on in succession, in the same manner as on the Goondah, only that here the people are in greater security. While these ropes are making fast, the other hunters are careful not to go too near, but keep on the outside of the palisade, and divert his attention as much as they can from those employed in fastening them, by supplying him with grass, and sometimes with plantain-leaves and sugar-canes, of which he is remarkably fond, by presenting a stick, giving him hopes of catching it, or by gently striking or tickling his proboscis. He frequently, however, seizes the ropes with his trunk, and endeavours to break them, particularly those with which his feet are tied, and sometimes tries to bite them through with his grinders (as he has no incisors or front teeth); but the hunters then goad him with sharpened bamboos, or light spears, so as to make him quit his hold. Those who are employed in putting the ropes around his body, and over his head, stand above him, on a small kind of platform, consisting of a few bars run across through the openings of the palisades; and as an elephant cannot see any thing that is above, and rather behind his head, they are very little incommoded by him, although he appears to smell them, and endeavours to catch them with his trunk. When the whole apparatus is properly secured, the ends of the two cables (Dools) which

* These are of the same form and size nearly as the Phands, but much shorter in proportion.

were

were faſtened round his neck, are brought forward to the end of the Roomee, where two female elephants are waiting; and to them theſe cables are made faſt. When every thing is ready, the door at the end of the outlet is opened, the croſs bars are removed, and the paſſage left clear. The ropes that tied his legs to the paliſades are looſened, and, if he does not advance readily, they goad him with long poles ſharpened at the ends or pointed with iron, and urge him on with their noiſe and din, and at the ſame time the females pull him gently forward: as ſoon as he has cleared the Roomee, his conductors ſeparate; ſo that if he attempts to go to one ſide, he is prevented by the elephant that pulls in the oppoſite direction, and *vice verſa*. The Bundahs which tie his hind legs, though but looſely, yet prevent his going faſt; and, thus ſituated, he is conducted like an enraged bull, that has a cord faſtened to his horns on each ſide, ſo that he cannot turn either to the right or left to avenge himſelf. In like manner is this noble animal led to the next tree, as the Goondahs before mentioned were. Sometimes he becomes obſtinate, and will not advance; in which caſe, while one of his conductors draws him forward, the other comes behind and puſhes him on: ſhould he lie down, ſhe puts her ſnout under and raiſes him up, ſupporting him on her knee, and with her head puſhing him forward with all her ſtrength; the hunters likewiſe aſſiſt by goading him, and urging him forward by their noiſe and din; ſometimes they are even obliged to put lighted torches near, in order to make him advance. In conducting ſmall elephants from the Roomee, only one cable and one Koomkee are made uſe of. As ſoon as each elephant is ſecured, he is left in charge to the Mahote, or keeper, who is appointed to attend and inſtruct him; and, under him, there are from two to five Coolies, according to the ſize of the elephant, in order to aſſiſt and to ſupply food and water, till he becomes ſo tractable as to bring the former himſelf. Theſe people erect a ſmall hut immediately before him, where the Mahote,

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or one of the Coolies, conftantly attends, fupplies him with food, and foothes and careffes him by a variety of little arts. Sometimes the Mahote threatens and even goads him with a long ftick pointed with iron, but more generally coaxes and flatters him, fcratching his head and trunk with a long bamboo fplit at one end into many pieces, and driving away the flies from any fores occafioned by the hurts and bruifes he got by his efforts to efcape from the Roomee. This animal's fkin is foft, confidering his great fize; is extremely fenfible, and is eafily cut or pierced, more fo than the fkin of moft large quadrupeds. The Mahote likewife keeps him cool, by fquirting water all over him, and ftanding without the reach of his trunk: in a few days he advances cautioufly to his fide, and ftrokes and pats him with his hand, fpeaking to him all the while in a foothing tone of voice, and in a little time he begins to know his keeper and obey his commands. By degrees the Mahote becomes familiar to him, and at length gets upon his back from one of the tame elephants, and, as the animal becomes more tractable, he advances gradually forward, towards his head, till at laft he is permitted to feat himfelf on his neck, from which place he afterwards regulates and directs all his motions. While they are training in this manner, the tame elephants lead out the others in turn, for the fake of exercife, and likewife to eafe their legs from the cords with which they are tied, and which are apt to gall them moft terribly unlefs they are regularly flacked and fhifted. In five or fix weeks the elephant becomes obedient to his keeper, his fetters are taken off by degrees, and generally in about five or fix months he fuffers himfelf to be conducted by the Mahote from one place to another: care, however, is always taken not to let him approach his former haunts, left a recollection of the freedom he there enjoyed fhould induce him again to recover his liberty. This obedience to his conductor feems to proceed partly from a fenfe of generofity, as it is in fome meafure voluntary; for, whenever

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an elephant takes fright, or is determined to run away, all the exertions of the Mahote cannot prevent him, even by beating or digging the pointed iron hook into his head, with which he directs him; on such an occasion the animal seems to disregard these feeble efforts, otherwise he would shake or pull him off with his trunk, and dash him in pieces. Accidents of this kind happen almost every year, especially to those Mahotes who attend the large Goondahs; but such accidents are in general owing entirely to their own carelessness and neglect. It is necessary to treat the males with much greater severity than the females, to keep them in awe; but it is too common a practice among the Mahotes, either to be negligent in using proper measures to render their elephants docile, or to trust too much to their good nature before they are thoroughly acquainted with their dispositions. The iron hook, with which they direct him, is pretty heavy, about sixteen inches long, with a straight spike advancing a little beyond the curve of the hook, so that altogether it is exactly like that which ferrymen or boatmen use fastened to a long pole.

In this account of the process for catching and taming elephants, I have used the masculine gender to avoid circumlocution, as both males and females are treated in the same manner: the former are seldom so docile, but, like the males of other animals, are fiercer, stronger, and more untractable than the females.

Before I conclude, it may be proper to observe, that young elephants suck constantly with their mouths, and never with their trunks *, as Buffon has asserted; a conclusion he made merely from conjecture, and the great and various uses to which they are well adapted and applied by every elephant.

* Aristotle says expresly, that the young elephants suck with their mouths, and not with their trunks: Ὁ δε σκυμνος ὁταν γενηται θηλαζει τῳ ςοματι ου τῷ μυκτηρι. Aristot Opera. Basiliæ 1500. fol. p. 494. EDIT.

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I have feen young ones from one day to three years old fucking their dams, but never faw them ufe their trunks, except to prefs the breaft, which, by natural inftinct, they feemed to know would make the milk flow more readily. The mode of connection between the male and female is now afcertained beyond the poffibility of a doubt; as Mr. Buller, Lieut. Hawkins, and many others, faw a male copulate with a female, after they were fecured in the Keddah, in a manner exactly fimilar to the conjunction of the horfe with a mare.

This fact entirely overturns what has been fo often related concerning the fuppofed delicacy of this ufeful animal, and a variety of other hypothefes, which are equally void of foundation. As far as I know, the exact time an elephant goes with young, has not yet been afcertained, but which cannot be lefs than two years, as one of the elephants brought forth a young one twenty-one months and three days after fhe was taken. She was obferved to be with young in April or May 1788, and fhe was only taken in January preceding; fo that it is very likely fhe muft have had connection with the male fome months before fhe was fecured, otherwife they could not difcover that fhe was with young, as a fœtus of lefs than fix months cannot well be fuppofed to make any alteration in the fize or fhape of fo large an animal. The young one, a male, was produced October 16th, 1789, and appeared in every refpect to have arrived at its full time. Mr. Harris, to whom it belongs, examined its mouth a few days after it was brought forth, and found that one of its grinders on each fide had partly cut the gum. It is now alive and well, and begins to chew a little grafs.

I have further to remark, that one of the tufks of the young elephant has made its appearance; fo that we can now afcertain it to be of that fpecies called Mucknah, the tufks of which are always fmall, and point nearly ftraight downwards.

downwards. He was thirty-five inches high at his birth, and is now thirty-nine; ſo that he has grown four inches in nearly as many months. Elephants are always meaſured at the ſhoulder; for the arch or curve of the back, of young ones particularly, is conſiderably higher than any other part, and it is a ſure ſign of old age whenever this curve is found flattened or conſiderably depreſſed, after an elephant has once attained his full growth.

Though theſe remarks, as well as ſeveral others in the above relation, do not come within the plan I propoſed, which was merely to deſcribe the method of taking wild elephants in the province of Tipura, yet I hope they will not be deemed impertinent or ſuperfluous, eſpecially as ſeveral of them tend to eſtabliſh ſome important facts in the natural hiſtory of this animal, that are not known, or not attended to, at leaſt in any accounts that I had an opportunity of ſeeing.

V. *Obſervations on the bodily Conformation and mental Capacity of the Negroes. By Profeſſor* BLUMENBACH. *From* Magazin für das neueſte aus der Phyſik, *Vol. IV.*

DURING a tour which I made through Swiſſerland, I ſaw in the picture-gallery at Pommersfeld four negro heads by Vandyk, two of which in particular had the lines of the face ſo regular that the features ſeemed very little different from the European. At that time, as I had never had an opportunity of acquiring a proper knowledge reſpecting the form of the negro head and cranium, by ſtudying nature, and as I remembered that Mr. Camper, in a diſſertation read in the Academy of Painting at Amſterdam, had mentioned that the greater part of the moſt eminent painters, and eſpecially Rubens, Vandyk and Jordaens, when they painted Moors, copied from Europeans, whoſe faces had been blackened for that purpoſe, I aſcribed the European look of the

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above negro heads to this common fault. Some months after, however, I had an opportunity of convincing myself that there are real negroes whose features correspond very nearly with those of the Europeans, and that the above heads in the gallery of Pommersfeld might be a true representation of nature.

Going to pay a visit at Yverdun to the two brothers Treytorrens, one of whom, the chevalier, had been thirty-five years in the French service, particularly at St. Domingo; and the other, by means of the opportunities which his brother enjoyed, had a collection of natural curiosities that contained many rare articles, when I entered the court of their elegant habitation, which is situated on the road to Goumoens, I saw no person to shew me into the house, except a woman of an agreeable figure, who was standing with her back towards me. When she turned round to give me an answer, I was much surprised to find that she was a female negro, whose face perfectly corresponded with her figure, and fully justified the fidelity of likeness in Vandyk's negro heads, which I had seen at Pommersfeld. All the features of her face, even the nose and lips, the latter of which were a little thick, though not so as to be disagreeable, had they been covered with a white skin, must have excited universal admiration. At the same time she was not only exceedingly lively, and possessed a sound understanding; but, as I afterwards learned, was extremely well informed and expert in the obstetric art. The handsome pretty negress of Yverdun is celebrated far and near as the best midwife in the Italian part of Swisserland. I was informed by her master, the chevalier, who has in his service also a negro man as elegantly formed as a statue, that she was a creole from St. Domingo; that both her parents were natives of Congo, but not so black as the negroes of Senegal.

Since that period I have had an opportunity of seeing and conversing with many negroes, and have procured for my collection a great many anatomical preparations from negro bodies,

bodies, which, together with what I have read in different voyages, tend more and more to convince me of the truth of the two following propositions :

1. That between one negro and another there is as much (if not more) difference in the colour, and particularly in the lineaments of the face, as between many real negroes, and other varieties of the human species.

2. That the negroes, in regard to their mental faculties and capacity, are not inferior to the rest of the human race.

The three negro skulls, which I have now before me, afford, by the very striking gradation with which the lineaments pass from the one to the other, a very evident proof of the first proposition. One of them, which Mr. Michaelis was so good as to bring me from New-York, and of which I have given an accurate description in another place*, is distinguished by such a projecting upper jaw-bone, that, if the same peculiarity belonged to all negroes, one might be tempted to suppose that they had another first parent than Adam. On the other hand, the lineaments of the third have so little of the exotic form, and are so different from the first, that if I had not dissected the whole head perfectly entire, and just as it was when cut from the body, I should be in doubt whether I ought to consider it as having actually belonged to a real negro. The second holds a mean rank between both, and in its whole form has a great likeness to the head of the Abyssinian Abbas Gregorius, a good engraving of which by Heiss, in 1691, from a painting by Von Sand, I have now before me, and which not only proves in general the close affinity of the Abyssinians with the negroes, but approaches much nearer to the ugly negroes, to speak according to the European ideas of beauty, than the well-formed negress of Yverdun, or the handsome young negro whose head I dissected as before mentioned, or than a thousand others whose features are little different from those of the Europeans. What I have here said is indeed nothing else than a confirmation of a truth long

* In my Osteology, p. 87.

known,

known, which has been already remarked by unprejudiced travellers, as will appear by the following quotations. Le Maire, in his Voyage to Cape Verd, Senegal, and Gambia*, says: "Blackness excepted, there are female negroes as well made as our ladies in Europe." Leguat, in his well-known Voyages †, tells us, that he found at Batavia several very pretty negresses, whose faces had the perfect European form. Adanson, in his Account of Senegal ‡, speaking of the female negroes there, has the following passage: "The women are almost as tall as the men, and equally well made. Their skin is remarkably fine and soft: their eyes are black and open; the mouth and lips small, and the features are well proportioned. Some of them are perfect beauties. They are exceedingly lively, and have an easy, free air, that is highly agreeable." Ulloa, in his *Noticias Americanas* ||, observes, that some of the negroes have thick projecting lips, a flat nose, eyes deeply sunk in the sockets, which in general are called *getudos*, and wool instead of hair. He then adds: "Others, whose colour is equally black, have features perfectly like those of the whites, particularly in regard to the nose and the eyes, and smooth but thick hair §."

* Voyages aux Cap Verd, Senegal et Gambie, p 161.

† Vol. ii. p. 136. ‡ Page 22. || Page 92.

§ The following observations of an intelligent Danish traveller may serve still farther to confirm the truth of Professor Blumenbach's proposition: "Almost all the negroes are of a good stature, and the Akra negroes have remarkably fine features. The contour of the face, indeed, among the generality of these people, is different from that of the Europeans; but at the same time faces are found among them which, excepting the black colour, would in Europe be considered as beautiful. In common, however, they have something apish. The cheek-bones and chin project very much; and the bones of the nose are smaller than among the Europeans. This last circumstance has probably given rise to the assertion, that the negro women flatten the noses of their children as soon as they are born. But noses may be seen among some of them as much elevated and as regular as those of the Europeans. Their hair is woolly, curled and black, but sometimes red. When continually combed, it may be brought to the length of half a yard; but it never can be kept smooth. See P. E. Isert Reis na Guinea. Dordrecht 1790. p. 175. EDIT.

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The testimonies and examples which serve to prove the truth of the second proposition, respecting the mental faculties, natural talents and ingenuity of the negroes, are equally numerous and incontrovertible. Their astonishing memories, their great activity, and their acuteness in trade, particularly with gold dust, against which the most experienced European merchant cannot be too much on his guard, are all circumstances so well known, that it is not necessary to enlarge on them*. The great aptitude of the slaves for learning every kind of nice handicraft is equally well known; and the case is the same in regard to their musical talents, as we have instances of negroes playing the violin in so masterly a manner, that they gained so much money as enabled them to purchase their liberty†.

Of the poetical genius of the negroes instances are known among both sexes. A female negro, who was a poetess, is mentioned by Haller; and a specimen of the Latin Poetry of Francis Williams, a negro, may be found in the History of Jamaica. The interesting letters of Ignatius Sancho, a negro, are well known; and the two following instances will serve as a farther proof of the capacity and talents of our black brethren, in regard to literature and science. The protestant clergyman J. J. Eliza Capitein was a negro; a man of considerable learning, and a great orator. I have in my possession an excellent print of him engraved by Tanjé, after P. Vandyk. Our worthy professor Hollman, when he was at Wittenberg, conferred the degree of Doctor of Phi-

* Barbot, in his Description of the Coasts of North and South Guinea, to be found in the fifth volume of Churchhill's Collection, relates many interesting things on this subject. Thus he says, p. 235. "The blacks are for the most part men of sense and wit enough, of a sharp ready apprehension, and an excellent memory beyond what is easy to imagine; for, though they can neither read nor write, they are always regular in the greatest hurry of business and trade, and seldom in confusion."

† See Urlsperger's Americanisch Ackerwerk Gottes, p. 311.

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losophy on a negro who had shewn himself to advantage, not only as a writer, but as a teacher, and who afterwards came to Berlin as a counsellor of state to his Prussian majesty. I have now before me two treatises written by him*, one of which, in particular, displays extensive and well-digested reading of the best physiological works of the time. Of the uncommon knowledge which many negroes have had in the practice of medicine, very favourable testimony has been given by Boerhaave and De Haen, who were certainly competent judges; and the sound skill and delicate expertness of the Yverdun accoucheuse are, as already said, celebrated throughout the whole neighbourhood.

To conclude, the Academy of Sciences at Paris had among the number of its correspondents M. Lislet a negro, in the Isle of France, who excelled in making accurate meteorolo-

* One of them is entitled: *Dissert. inaug. philosophica de humanæ mentis απαθεια, sive sensionis ac facultatis in mente humana absentia, et earum in corpore nostro organico ac vivo præsentia, quam* Præs. D. MART. GOTTH. LOESCHERO *publicè defendit auctor* ANT. GUIL. AMO, Guinea-Afer, Phil. et A.A. L.L. Mag. et J. V. C. *Wittebergæ* 1734, *m. Apr.* The title of the other is: *Disp. philosophica, continens ideam distinctam eorum quæ competunt vel menti vel corpori nostro vivo et organico, quam Præside* M. ANT. GUIL. AMO, Guinea-Afro, *d.* 29. *Maii* 1734, *defendit* Jo. THEODOS, Meiner Rochliz-Misnie. Philos. et J. V. Cultor. In an account of Amo's life, printed on this occasion in name of the Academic Council, it is said, among other things respecting his talents: "Honorem, meritis ingenii partum, insigni probitatis, industriæ, eruditionis, quam publicis privatisque exercitationibus declaravit, laude auxit—Compluribus philosophiam domi tradidit excussis tam veterum, quam novorum, placitis, optima quæque selegit, selecta enucleatè ac dilucidè interpretatus est." And the president, in defending the first mentioned treatise, says expressly, in the annexed congratulation to Amo, "Tuum potissimum eminet ingenium felicissimum—utpote qui istius felicitatem ac præstantiam, eruditionis ac doctrinæ soliditatem ac elegantiam, multis speciminibus hactenus in nostra etiam academia magno cum applausu omnibus bonis, et in præsenti dissertatione egregiè comprobasti. Reddo tibi illam proprio marte eleganter ac eruditè elaboratam, integram adhuc et planè immutatam, ut vis ingenii tui eo magis exinde elucescat.

 gical

gical obſervations. On the other hand, whole provinces of Europe might, in my opinion, be named, from which it would be difficult to produce at preſent virtuoſo's, poets, philoſophers, and correſpondents of a learned academy.

VI. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE. *From* Journal des Mines. *No. XX.*

[Continued from page 41.]

CHAP. VI.

Obſervations to be made on Rivers and other Currents of Water.

1. EXTENT of their courſe, and their inclination from their ſources to their mouth.

2. Their dimenſions, breadth, depth and velocity in the different parts of their courſe.

3. Quantity of their periodical increaſe and decreaſe at different ſeaſons; their temperature during theſe ſeaſons; and the cauſes of theſe variations.

4. Limits and cauſes of their extraordinary inundations.

5. Whether they are navigable, and to what diſtance from their mouth?

6. The nature, purity, and ſalubrity of their waters.

7. The nature of the ſand or mud which they carry along with them; and to what diſtance they may be traced on the banks or at the bottom of the ſea where their mouths are ſituated. M. Beſſon even wiſhes that the traveller ſhould be furniſhed with a wooden veſſel (*ſebille*) to waſh the ſand and ſeparate the more ponderous particles, which may conſiſt of metal or precious ſtones. The motion of the waves is alſo

often ſufficient to ſeparate, in diſtinct bands or zones, particles of different gravity *.

8. Nature of the rolled pebbles found on their borders.

9. The quantity and kinds of fiſh by which they are characteriſed.

10. To enquire, as in regard to the ſea, whether it appears that they contain more or leſs water than formerly, and whether they have changed their courſes.

11. As the greater part of theſe queſtions may be applied to lakes, it is not neceſſary to make them the ſubject of a ſeparate chapter. I ſhall inſiſt only on their nature and the meaſure of their depth; on the temperature of their bottom compared with that at their ſurface in different ſeaſons; and alſo on the veſtiges of their extent and height in the remoteſt ages, compared with their preſent ſtate.

CHAP. VII.

Obſervations to be made on the Plains.

1. The extent, limits and inclination of a plain; its height above the level of the ſea; its relation with the hills or mountains by which it is bordered. To form a proper idea of it as a whole, it would be neceſſary to aſcend ſome eminence commanding a view over it.

2. The vegetable earth; its nature and thickneſs in different parts, compared with the time ſince it has been cultivated, with its productions, and the kind o culture. The nature of the baſis on which that earth reſts.

3. Rolled pebbles. (*See Chap.* VIII.)

4. Sand, argil; their nature; thickneſs of their beds.

5. Nature and thickneſs of the ſtrata of the earth at the greateſt depth poſſible to be reached, by taking advantage of the time when wells, mines and other excavations are dug.

* Moyens de rendre utiles les voyages des naturaliſtes, Eſprit des Journaux, Avril 1794.

This

This research is particularly interesting when these excavations are extended below the level of the sea.

6. Marl-pits; their external appearances; whether they contain shells, and of what kinds; extent of their beds, and their thickness; analysis of them, at least with acetous acid; the uses for which the marl is employed.

7. Clay-pits; quarries of lime-stone, gypsum; mines of coal, &c.

8. Whether the plains exhibit at their surface, or contain in the interior parts of the earth, vestiges of marine bodies, petrified wood, bones or other substances foreign to the soil and to the country.

9. Internal temperature of the earth, ascertained either by direct experiments, or by observing that of the deepest wells or cellars; or by that of springs, which do not freeze in winter, and which remaining cool in summer, seem to come from the greatest depths.

10. Whether any fact can be observed which might oblige us to have recourse to the hypothesis of a central fire.

11. Basons surrounded by hills or mountains; whether they seem to have been formerly filled with water; whether the water appears to have been fresh or salt; whether any thing indicates the period of its retreat, and if there are any traces of the apertures through which it escaped.

CHAP. VIII.

Observations to be made on Rolled Pebbles.

1. The nature and size of those found in any particular district.

2. To examine, above all, whether there is any kind which may be considered as peculiar to that district, or which may be proper to characterise it; or even, whether the absence of any kind or class might not be sufficient to form that character.

3. Whether thoſe found on the borders of any river might be conſidered as having been thrown up by that river, or whether it only expoſed them to view by waſhing away the ſoil which it watered.

4. After eſtabliſhing the character of the pebbles of a certain diſtrict, one might follow, as it were, their traces, and form conjectures both reſpecting their origin and the route they have purſued.

5. The increaſe of their ſize will ſhew that they approach their origin, or *vice verſa*; but care muſt be taken that other veins of pebbles croſſing the former may not conceal the courſe of thoſe which you are tracing out.

6. A conſideration of the pebbles, and ſtill more that of rolled blocks, or, at leaſt, ſuch as are foreign to the ſoil which bears them; of the height at which they are found, and of the large valleys oppoſite to their preſent ſituation, may afford ſome indications of the direction, ſize and force of the currents produced by the grand revolutions of the earth.

7. A conſideration of thoſe blocks which reſt on ſolid rock, and which ſeem ſtill to occupy the place where they were depoſited, may, by the ſtate of theſe rocks, give an idea of the time elapſed ſince their arrival.

8. How far can the tranſportation of theſe great blocks to conſiderable diſtances be conſidered as a general phenomenon? or, is it only a particular phenomenon, ariſing from ſome local cauſe?

9. Can it be believed that ſuch of thoſe blocks as at preſent occupy elevated ſites on mountains, have been tranſported by billows or waves, which raiſed them gradually from the bottom of the valleys, and that they muſt at firſt have deſcended to theſe elevated ſituations *?

10. Or was it by enormous tides, of eight hundred toiſes

* May not the tranſportation of theſe blocks, at leaſt in cold countries, be aſcribed ſometimes to floating ice? C.

for

for example, that these blocks were transported to the tops of the mountains?

CHAP. IX.

On Mountains in general.

1. To consider whether a mountain be insulated, or whether it forms part of an assemblage of mountains connected with each other in the form of groups or chains.

2. If it be a group, to determine its form and dimensions, and the manner in which its parts are connected.

3. If it be a chain, to determine its direction, its breadth, and its extent; whether it be single or compound; and, in the latter case, the nature and disposition of the partial chains which enter into its composition.

4. If a mountain be insulated or considered separately from its chain, or the group of which it forms a part, to determine its form, its height, and other dimensions.

5. To determine the form and situation of its summit or most elevated part; those of its declivities and bottom.

6. The situation of its precipices in regard to the sea and the nearest plains, valleys, and mountains *.

7. Its nature, and the kind of stone of which it is composed. Whether it be homogeneous; that is to say, of the same nature throughout all its parts; if it be not, to determine the dimensions of its different parts.

8. Whether it consists of indivisible masses, or masses divided by strata.

9. Whether it contains mines either in veins or strata: the nature of these mines.

10. To observe the height at which the snow is perpetual, or what Bouguer calls *the lower limits of the snow*, and the height at which trees, shrubs, and plants, with distinct flowers, cease to grow. These observations have been neglected in the northern countries.

* And in regard to the four cardinal points; whether any side is more steep than another, and which side? C.

11. To obferve carefully the increafe or decreafe of the glaciers: to determine them, in particular, by what are called *moraines*, that is to fay, thofe heaps of ftones now or formerly depofited by the glaciers on their edges and at their extremities.

11. A. To afcertain whether there are found in the mountains funk or petrified trees, at heights at which they would not grow at prefent; and to examine if it thence follows that there may have been a time when the upper ftrata of the atmofphere were warmer than they are at prefent.

12. Caverns: if there are any, their form and dimenfions; the nature of their fides; the nature and inclination of their bottom; veftiges of the effects of the water by which they may have been formed; ftalactites and incruftations, foreign bodies and bones which they may contain.

13. Whether there are found veftiges of large bafons difpofed in ftories above each other, and which might have ferved as refervoirs to different feas that afterwards might have run off and united themfelves in the bafons of the prefent feas.

CHAP. X.

Obfervations to be made on the Strata of the Earth and Mountains.

1. The firft queftion is to determine whether a mountain or any mafs of earth and ftone is or is not divided by ftrata*.

2. What, in regard to the theory of the earth, gives importance to the queftion, whether a mountain is or is not

* The word *ftratum*, originally fynonimous with that of *bed*, expreffed the fituation of a fubftance extended horizontally, and with an uniform thicknefs, on a plain and horizontal bafe. But the fignification of this word has been enlarged, and it is now employed to exprefs the fituation of fubftances extended with an equal or almoft equal thicknefs on bafes which are neither plain nor horizontal. *Note of the Author.*

Might not the term *ftratum* be referved for thofe that are horizontal, and the name of *banks* be given to others? C.

ftratified,

ſtratified, or compoſed of ſtrata, is the ſuppoſition that ſtratified mountains have been formed by the ſucceſſive depoſition of ſubſtances before ſuſpended in a fluid, while thoſe which exhibit no ſigns of ſtrata may be ſuppoſed to owe their origin to a ſimultaneous creation, or an accumulation not formed in a fluid, or which, at leaſt, had nothing ſucceſſive or regular, or in which there remain no traces of regularity.

3. If the mountain or maſs exhibits no marks of diviſion, the queſtion of its being ſtratified or not is ſuperfluous. We ſhall ſuppoſe then that it preſents diviſions, and require to know whether theſe diviſions may be called *ſtrata*. The ſolution of this queſtion depends upon three conſiderations: viz. The regularity of theſe diviſions, or their paralleliſm. Their number: the greater the number, the more it excludes the idea of fortuitous paralleliſm. The paralleliſm of theſe diviſions with the laminæ or parts diſcernible in the inſide of the maſs.

4. Though the ſtrata, in general, have the form of a parallelopipedon, ſome are ſeen cuneiform; in others are obſerved alternate ſwellings and conſtrictions; and others are ſeen ramified, dividing themſelves ſometimes into two or three, or two and three uniting and forming themſelves into one.

5. Beſides the form of the ſtrata, to obſerve their extent, either in the ſame mountain, or in ſeveral mountains near each other, or even at a diſtance.

6. To obſerve alſo their inclination, or the angle which they form with a horizontal line, and the point of the horizon to which their declivity is directed.

This laſt obſervation determines the direction of their planes, or the two oppoſite points of the horizon through which their planes would paſs, were they prolonged, after being made entirely ſtraight. This direction of the planes is of importance to be conſidered, eſpecially in vertical ſtrata.

7. To examine whether this direction is parallel, oblique or tranſverſe to the direction of the body itſelf of the mountain,

tain, the chain of which it makes a part, and the adjacent valleys.

8. To examine alſo whether the declivity of the ſtrata is conformable to that of the external ſurface of the mountain; that is to ſay, whether they deſcend towards the outſide of the mountain, or towards the interior part.

9. To examine next whether the inclination is the ſame from the bottom of the mountain to the ſummit, or whether it varies at different heights; whether it be the ſame or different at the oppoſite ſides of the ſame mountain. Strata in the form of a fan *.

10. It is of importance to obſerve, in inclined or vertical ſtrata, whether their thickneſs is not greater at their baſis than at their ſummit.

11. To obſerve the joinings of the ſtrata, and whether any ſubſtance different from that of the ſtrata is placed between them, and what is the nature and thickneſs of this ſubſtance.

12. To obſerve whether the contiguous or correſponding joinings of theſe ſtrata are ſmooth or unequal; whether there are obſerved in them any knots that exhibit traces of cryſtalliſation or undulations proceeding in a certain direction.

13. In mountains conſiſting of ſtrata different in their nature, or of different thickneſs, to obſerve whether their return is periodical, ſo that the ſame order recommences after a certain number or determined interval.

14. Whether, at the bottom of a mountain conſiſting of horizontal ſtrata, there are not found mountains compoſed of vertical ſtrata reſting againſt the baſis of that mountain.

15. In bent or circular ſtrata, to obſerve in the elbows or points where the flexion is greateſt, whether the ſtrata are or are not broken.

16. When the ſtrata have the form of a C, to obſerve whether at the back of the C there is not a vacuity, which proves that the upper part has been thrown above the under part.

* Voyages dans les Alpes. § 656 and 677.

17. To

17. To examine, in general, whether the ſtrata exhibit traces of violent convulſions, which may have changed their primitive ſituation; or, on the contrary, whether the whole, as well as the ſtraightening of the ſtrata, may be explained by ſimple ſinking down *.

CHAP. XI.

Obſervations to be made on Fiſſures.

1. Their form, dimenſions, breadth, extent, and direction.

2. Their ſituation; meaſure of their inclination; direction of that inclination in regard to the cardinal points, and in regard to the adjacent mountain and valleys.

4. To obſerve, above all, the direction of fiſſures in regard to that of the planes of the ſtrata; becauſe fiſſures, as is preſumed, being produced, in general, by the earth ſinking down, and this ſinking down being the effect of preſſure, fiſſures have been originally vertical or nearly ſo; and, on the other hand, becauſe the ſtrata having originally been horizontal or nearly ſo, the ſituation of fiſſures, in regard to the ſtrata, and the direction of both in regard to the horizon, may give ſome idea of the ſituation which the ſtrata had when the fiſſures were formed, and even of the changes of ſituation which the mountain afterwards experienced.

Thus, fiſſures perpendicular to the planes of the ſtrata, indicate that theſe fiſſures were formed when the mountain was ſtill in its primitive ſituation; and if they are alſo perpendicular to the horizon, it proves that the mountain is ſtill in the ſame ſituation; but if fiſſures perpendicular to the ſtrata are inclined to the horizon, we may conclude that the mountain has changed its ſituation ſince theſe fiſſures were formed †.

* 18. To obſerve, whether, on approaching the high primitive mountains, the calcareous ſtrata do not ſeem to have been reverſed in a more violent manner. B.

† An explanation and application of theſe principles may be ſeen in my Travels, § 1048, 49, 50, and 1218.

5. When

5. When the fiſſures are filled with matter different from the body of the mountain, that matter is called a vein.

6. Laſtly, one muſt examine, in both ſides of the ſame fiſſure, whether the ſtrata correſpond at the ſame height, or whether the correſponding ſtrata are lower on one ſide than on the other. The firſt caſe indicates that the fiſſure has been produced by mere burſting aſunder; and the ſecond proves, beſides, a ſinking down of the earth *.

[To be continued.]

VII. *Obſervations on the Winter Sleep of Animals and Plants. By Profeſſor* FABRICIUS. *From* Magazin für das neueſte aus der Phyſik. *Vol. IX.*

THE ſo called winter ſleep is a very ſingular property of animals and plants; and though it occurs daily before our eyes, we are not able to explain the phenomena with which it is attended. In cold countries many animals, on the approach of winter, retire to their ſubterranean abodes, in which they bury themſelves under the ſnow, where they remain five or ſix months without nouriſhment or motion; nay, almoſt without circulation of their blood, which flows only ſluggiſhly and in the wideſt veſſels. Their perſpiration is almoſt imperceptible: but ſtill they loſe ſomething by it; as they enter their winter quarters in very good condition, and are exceedingly thin when they return from them.

Some animals enjoy their winter ſleep under the earth, and others concealed below the ſnow; ſome for the ſame purpoſe creep into the holes of rocks, and others below ſtones or the bark of trees. Some kinds, ſuch as ſwallows and frogs, can paſs the winter in marſhes under the water. In this ſtate many of thoſe expoſed to the ſeverity of the

* To obſerve whether this ſinking down has not always taken place on that ſide which looks towards the flat country. C.

open air are deftroyed by the froft when it is violent; and even fome of thofe which have buried themfelves fhare the like fate.

Plants have their winter fleep alfo; for, during the period of winter, their fap flows towards the root, and the circulation of it, which is very flow, takes place only in the wideft veffels. Were the expanfion of the fap in winter as confiderable as in fummer, it would burft all the veffels on being frozen.

Several obfervers have endeavoured to prove that this fingular circumftance is merely accidental; and, indeed, no difference is found in the internal organization of thofe animals which have winter fleep, and thofe which have not. It is very remarkable that this property belongs in general to animals of prey. As thefe have far ftronger powers of digeftion, and ftronger digeftive juices, it would appear that abftinence from food for feveral months would to them be hardly poffible.

The bear, the bat and the hedge-hog have winter fleep; but the white bear has not. As the latter is fecured from the cold by his long hair, he finds nourifhment in the dead whales and feals which are caft on fhore by the waves.

The earth worms have winter fleep; but aquatic worms very feldom. Infects, as well as their larvæ, have winter fleep. Butterflies may be often feen fluttering about in the warm days of fpring, after having fpent the whole winter in that condition. Amphibious animals have winter fleep, thofe which live merely in the ocean excepted.

Few birds, on the other hand, are expofed to this ftate. The greater part of thefe, on the approach of winter, retire to a milder climate where they can find more abundant nourifhment.

In Iceland the fheep have winter fleep, becaufe in that country they are fuffered to range in perfect freedom. In the winter feafon therefore they may be feen buried under the fnow and in the bufhes, where it would be impoffible for them to remain were they not in that condition.

VIII. *Ex-*

VIII. *Experiments made to aſcertain the Compoſition of the Swediſh Stone Paper or Artificial Slate. By* J. G. GEORGI. *From the* New Tranſactions of the Imperial Academy at Peterſburgh, *Vol. IV.*

THE invention of Arfuid Faxe, confirmed by many experiments tried at Carlſcrona, but not yet communicated to the public, for making a certain kind of artificial ſlate or ſtone paper, which may be procured at a ſmall expence, and can be employed inſtead of common ſlate, was announced and highly extolled a few years ago in ſeveral of the public journals. This ſubſtance was ſaid to have a great reſemblance to milled or paſte-board; to be of an iron-red, white, or yellow colour; to be very hard and ſtiff, but ſomewhat elaſtic; to be ſubject to no alteration even when immerſed in cold water for ſeveral months, or when boiled for ſeveral hours; to be hardened by expoſure to the air; to reſiſt fire a long time, and to burn ſlowly, after having experienced a great degree of heat, but, when left to itſelf, to become ſoon extinguiſhed.

It is evident, therefore, that this paper may be applied to various economical purpoſes, ſuch as ſheathing ſhips, which it would not only preſerve from rottenneſs, but alſo from being deſtroyed by worms; for guarding from fire the cooking places in ſhips and powder magazines, and, laſtly, for covering houſes and wooden buildings. To this it may be added, that plates of this paper fixed on with braſs nails, and done over at the joinings with cement, might be covered with ſome oil varniſh in ſuch a manner as to be altogether impenetrable to moiſture. We are told alſo that a ſmall building conſtructed of wood at Carlſcrona, and caſed over with ſtone paper, after being filled with combuſtibles and ſet on fire, reſiſted the effects of the flames and remained unhurt, and that the ſame experiment repeated at Berlin on a ſmaller building was attended with the ſame reſult. One great advantage of this ſtone-paper alſo is, that it is exceedingly

ingly light, and may in general be procured at a cheaper rate than any other materials for covering roofs, as a plate of it 23 inches in length and 14 inches in breadth coſts at Carlſcrona only two ſchellings Swediſh.

An invention of ſuch utility and importance ought therefore to excite the ingenious to attempt an imitation of it, in order that, if poſſible, it may be rendered more public. As ſoon as I obtained a ſpecimen of it from Sweden, I made experiments to try whether I could not diſcover the method of making it. The fragment which I firſt examined was a line in thickneſs. It was light, eaſily broken, and poſſeſſed all the properties above enumerated. As the analyſis by which M. Antic de Servin, at the requeſt of M. Crell, endeavoured to illuſtrate the nature of this paper, did not appear to me ſatisfactory, I ſubjected part of the ſpecimen ſent me to a farther examination, leaving a third portion entire for the ſake of compariſon.

After this examination the red ſtone-paper appeared to me to conſiſt of, 1. Martial-bole, which ſeemed to be equal to half its weight, and which, on account of the chalk perhaps, or calcareous earth with which it was mixed, produced a little efferveſcence with acids. Perhaps alſo there were ſome particles of another earth, the diſcovery of which would be of little importance to the object of this reſearch. 2. A vegetable matter of little weight, and ſimilar to that uſed in the making of common paper. This formed about a fourth part of the weight. 3. An animal glue, ſimilar to that which is procured by boiling from various animal ſubſtances: and, 4. A certain oil which ſeemed to have a reſemblance to linſeed oil. Theſe ſubſtances (3 and 4) made about a fourth part of the weight.

Another ſpecimen which I received from Mr. Cameron, architect to her imperial majeſty, contained the ſame ſubſtances in proportions a little different. I was, however, not able to obtain ſpecimens of the white and yellow ſtone-paper,

in

in which M. Servin obferved fome traces of martial vitriol (*fulphat of iron*).

Though I made a number of experiments in order to difcover the compofition of this flate, I fhall here mention thofe only which were attended with the beft fuccefs. But, to avoid repetition, I fhall firft defcribe that previous manipulation which appeared moft convenient.

The red or white bole, carpenter's ochre and chalk, which I employed for this ufe, were reduced to a fine powder. A pulpy mafs of the coarfeft kind, procured from a paper-manufactory, after being macerated in water, was ftrongly preffed and weighed out for ufe. The weight was increafed about two-thirds by the moifture. In giving an account of the following experiments, I fhall mention the weight of this fubftance as alluding to it when dry.

The glue was diffolved in a moderate quantity of water. I added martial vitriol undiffolved, and employed unboiled linfeed oil.

For want of a fufficient quantity of raw pulp, I procured, for fome experiments, fragments of coarfe old paper and bookbinder's fhavings, which, after being boiled for about three hours, were much tenderer than that brought from the paper manufactory. A pound of this when wet, after it had been preffed, exceeded that which was dry by about two-thirds.

The pulp procured from a paper manufactory being mixed in a mortar with the diffolved gluten, and being afterwards formed into a pafte by the addition of the above earths and fulphat of iron, was well beat up in the mortar, and linfeed oil then poured over it. The mafs, being prepared in this manner, was fpread out with a fpatula above a fheet of coarfe paper placed on a board furnifhed with a rim or border; another fheet of the fame paper was then fpread over it, and a fecond board was placed above all. The whole being then inverted, the board with the rim was taken off, and then the

firft

first sheet of paper. The compressed mass was then laid over upon another board sprinkled with sand, and left to dry, after taking the sheet of paper from its other side. Squares made in this manner dry without cracking; but as they become warped, it is necessary afterwards to flatten them, by putting them, with boards between, under a screw-press, and letting them stand for some time.

Exp. I. I mixed an ounce and a half of the dry pulp from the mill with two ounces of common glue, and, having added red bole and ochre, of each two ounces, obtained a smooth plate.

II. To two ounces of pulp I added four ounces of red bole pulverised, and half an ounce of chalk, with an ounce and a half of glue. The plate thus produced was full of wrinkles and chinks, but tolerably hard.

III. An ounce and a half of pulp, with four ounces of bole, and two of sulphat of iron, produced a plate equally hard, but uneven.

IV. An ounce of pulp procured from old paper and bookbinder's shavings mixed, with half an ounce of glue, an ounce of powdered chalk, two of bole, and an ounce of linseed oil, produced two thin plates smooth and hard.

V. Two ounces of pulp from the mill, with half an ounce of glue, six ounces of red bole and two of chalk, to which were added two ounces of sulphat of iron, and the same quantity of linseed oil, afforded plates that were smooth, but not strong.

VI. An ounce and a half of pulp, with an ounce of glue, and four ounces of white bole, produced a plate smooth, beautiful, and hard.

VII. An ounce and a half of pulp, mixed with two ounces of glue, two ounces of white bole, and as much chalk, yielded a smooth plate as hard as bone.

VIII. An ounce of pulp, one ounce of glue, three ounces of white bole, and an ounce of linseed oil, produced a plate sufficiently perfect and elastic.

IX. A plate which I formed of an ounce of pulp, with half an ounce of glue, three ounces of white bole, an ounce of chalk, and an ounce and a half of linseed oil, was superior to that mentioned in the preceding experiment. This substance retains figures impressed upon it, and, tinged with half a dram of Prussian blue, assumed a blueish green colour.

X. An ounce and a half of pulp, with an ounce of glue and four ounces of chalk, afforded a plate exceedingly spongy.

XI. An ounce and a half of the same pulp, one ounce of sulphat of iron, and four ounces of white bole, without glue, produced a plate yellowish and spongy.

XII. An ounce and a half of pulp, four ounces of white bole, with an ounce of sulphat of iron, and the same quantity of glue, produced a yellowish plate a little more solid.

I tried several other mixtures; but as the plates they produced were of an inferior quality, I shall not give any account of them. The plates which had been prepared in the above manner I cut into several pieces, and daubed over a specimen of each with boiled linseed oil. The parts covered with the oil assumed a darker colour, and the superficies acquired more solidity, nor were they less capable of resisting fire.

Being desirous of comparing the productions of my experiments with specimens of the Swedish stone-paper, I macerated about an inch square of each in cold water. After they had been macerated four months, the specimens prepared with sulphat of iron were considerably swelled, but those made without linseed oil seemed to have scarcely swelled at all. Those, however, which I had daubed over with boiled linseed oil or linseed oil varnish, exhibited as little appearance of change as the Swedish.

I put a square inch of each of the different kinds upon an iron spatula, together with a like quantity of beech wood, and exposed the whole to a strong heat in the mouth of a furnace. After fifteen minutes the wood began to burn, and in fifteen minutes more was reduced to ashes. The fragments

fragments of the different specimens of the stone paper, exposed to the same heat, were in such a state of ignition that they hissed when immersed in water. I however examined them with great attention. The fragment of the Swedish manufacture was somewhat black on the surface, and puffed up into small blisters; but did not seem to have burnt, or to have changed its form. The specimens prepared with the sulphat, being more spongy at the edges, burnt; but so slowly, that in those of the worst quality the fourth part was scarcely consumed in the above time. All the rest, inferior in nothing to the Swedish specimen, resisted the fire with equal strength; so that most of them were only a little blackish on the surface, and entirely free from blisters; nor did there appear any difference that could be ascribed to the glue or linseed oil employed, as they were all of the same consistence, and none of them seemed to have been warped by the heat.

I then put some of the same fragments toasted in the fire on a red-hot plate of iron, and immediately exposed them for fifteen minutes to a strong heat in the middle of a furnace. The Swedish specimen burnt, and for five minutes emitted a thick smoke; then appeared of a white heat for some time, and at the end of fifteen minutes was converted into three friable cineritious laminæ. The specimen produced by my first experiment burnt in the course of a minute, kept up a flame for three minutes, and in fifteen minutes was converted into a black plate sufficiently hard. Specimens of the second, third and fourth experiments exhibited the same appearances. A plate produced by the fifth experiment was sooner destroyed by the fire, and appeared friable like the Swedish. A plate of the sixth experiment, which before had been scarcely changed by the fire, bore the last exposure exceedingly well; was scarcely changed in its form and magnitude, continued sufficiently hard, and was only rendered black and as it were scorched. A specimen of the seventh experiment burnt for a whole minute, and became black and friable like the preceding. A ſpecimen of the eighth burnt for two minutes, and then continued black and ſufficiently hard. The ſame was the caſe almoſt with the ninth ſpecimen. A ſpecimen of the tenth, though it became black, was however ſcarcely changed. A fragment of the eleventh experiment burnt with a flame for about two minutes, and was converted into aſhes; which was the caſe alſo with the ſpecimen produced by the twelfth experiment.

Thoſe ſpecimens produced by my fourth, ſixth, ſeventh, eighth and ninth experiments, ſeemed to be the beſt in their external qualities and their power of withſtanding fire and water. The ſame fragments ſuffered as little from the influence of the weather and atmoſphere as the Swediſh. The materials for making this article may be readily procured for a ſmall price; and the proceſs is ſimple, and requires very little time. My ſpecimens indeed were not ſo neat and elegant as the Swediſh; but this inferiority may be obviated by practice and experience: and even in its imperfect ſtate the invention may be of great economical utility.

The cement which the Swedes recommend for filling up the interſtices between the ſquares, and of which I received a ſpecimen from Mr. Cameron, was compoſed of linſeed oil varniſh, white lead and chalk, mixed together in ſuch a manner as to approach to a fluid ſtate, that it might more eaſily inſinuate itſelf into the fiſſures.

As the chief uſe of this invention is to cover and incruſt houſes, I was deſirous of trying my production by expoſing it to the effects of the weather. I therefore nailed fragments of the Swediſh ſtone paper, and of that made by myſelf, to a ſmall board; and having daubed over the joinings with cement, I expoſed them in the month of Auguſt on the top of my houſe, and in the beginning of April the next year I found they had undergone no change.

IX. On

IX. *On the so called Sea Froth and other Substances of which the Bowls of the Turkish Pipes are made. From a Letter written in Persia by Dr.* Reinegg, *Correspondent of the Royal Society at Gottingen, to* Baron Von Asch *at Petersburgh. Communicated to the Society by Professor* Blumenbach.

THE so called sea-froth (*lithomarga*), of which the bowls of the Turkish pipes are made, is not an artificial composition, but a natural kind of earth dug up near Konie in Natolia. This place, the ancient Iconium, lies in a most fruitful district, which may be truly called a terrestrial paradise; and is celebrated on account of a large monastery of Dervises founded by the Scheik Abid il Daher, but which received particular endowments from Sultan Suleiman, and in which at present there are two hundred Dervises under the direction of a Scheik, by whom they are clothed and maintained.

The income of this monastery arises in part from some natural productions of that district, such as marble, &c. and in particular from the above-mentioned yellowish white earth, of which the bowls of the Turkish pipes are made. It is dug up at Kiltschik, (that is, the place of clay,) a village five miles distant from Konie; and besides this I have heard of no other place, either in Natolia or along the coast of the Mediterranean sea, where any of the like kind is produced. It is found in a large fissure six feet wide, in grey calcareous earth; and the workmen assert that the earth grows again in the fissure, and puffs itself up like froth. They therefore call it *kill-keffi*, or *kill-kefi*, a word which, if I read with Teschdid, *kill-keffi*, signifies clay-froth, or light clay.

This earth, when it comes from the fissure, is heavy, soft and greasy. It sweats if thrown into the fire; produces a fetid vapour; grows hard, and becomes perfectly white. The fresh earth dissolves in no acid. That which has been

 burnt

burnt can be acted upon only by the nitrous acid; but not until the solution has been continued a considerable time in heat, and then it loses nearly a third of its weight. When water is poured on the pure solution, it becomes a little muddy; and when it is suffered to evaporate entirely, a bitter salt exceedingly easy to be dissolved is obtained. The undissolved earth, fused in a strong fire, is converted into a brown slag. The fresh earth remains in water unchanged; and when it has been mixed with it by shaking and stirring, it falls again to the bottom, loses its cohesion, and cannot be again used. The earth, after being burnt, imbibes a large quantity of water, throws out abundance of air bubbles, and becomes soft.

The peasants of the village of Kiltschik dig up a sufficient quantity of this earth, for which they pay a certain sum to the monastery, and then cut it into bowls for tobacco pipes. For the most part, however, they press the earth, while yet soft, into proper moulds in which the figures of various flowers have been cut; and while the bowls are in these moulds they bore the holes in them, and then lay the bowls in the sun to dry. Some days after, when the surface of them is covered with a hard yellowish crust, they place the whole quantity of bowls in a heated baker's oven, and let them remain there till it is entirely cooled. They then boil them for an hour in milk; and when they are taken from it, they rub them with *Bischik Kuirughi* (*equisetum*) common horse tail, in order to make them smooth and shining, which is at length completely effected by means of a piece of soft leather.

When the bowls have been prepared in this manner, and sent to Constantinople for sale, they are dyed there of different colours, partly by being boiled in wax or oil. The best mixture, however, is dragon's blood and nut-oil; for when the bowls have been well soaked in this mixture and penetrated by it, they acquire, in a short time, a most beautiful dark-red dye. The Turks, however, in general are

not

not very fond of tobacco pipes made of sea-froth: and they are seldom used by the Asiatics; for they are too heavy, hold too much tobacco, and in some measure lessen the agreeableness of its taste. The Turks, therefore, prefer pipe-bowls made of red clay, and sell the former chiefly to the Greeks, who transport them to Transilvania and Hungary.

These small red pipe bowls are, on the other hand, in common use throughout all Lesser Asia, Arabia, Egypt, &c. and are formed of a real kind of clay-earth; but in places where that clay-earth is not to be found, they are imitated by some artificial composition, which is indeed preferable; for those burnt of clay have in general a pale red colour, whereas those made artificially have a beautiful high colour. The earth of which these bowls are made is not a red bolus, but a blueish argillaceous species of potter's earth. Such, at least, were those which I saw at Trebisond, Poli, and Cæsarea; where an immense number of these pipe-bowls are made.

In those places, on the other hand, where this species of potter's earth cannot easily be procured, or is not valued, as at Constantinople and Tocat, the pipe-bowls are prepared in the following manner:—Small fragments of thoroughly burnt tiles, particularly old ones, are pounded and then reduced to fine powder in a mill. Three parts of this tile-dust are then mixed with one part of any well washed argillaceous earth in pits made for the purpose, or in wooden boxes, and water to the height of a few inches is poured over it. This mass is daily stirred during a week; the water is poured off and fresh water poured on every evening; at the end of the week the whole paste is well stirred round with sticks, and when the useless coarse sandy parts begin to sink to the bottom, the remaining muddy water is drained off into other vessels, where it is suffered to remain till the argillaceous paste falls to the bottom and the water has again become clear. The remaining water is then carefully drained off, and the clayey cake, as it dries, is well kneaded. As soon as it is so dry as to be fit for being worked, it is mixed with a somewhat less quantity of umber, and formed into pipe-bowls, either in a mould, or by being applied to the lath.

When these bowls have been sufficiently burnt, they acquire a dark brown colour, which, however, changes into a beautiful red as soon as they have been well rubbed with a piece of leather sprinkled over with fine pulverised bloodstone (*hematites*). Owing to this simple process we obtain from the East those red pipe-bowls, so much and so generally esteemed, at a very low price, as five of them are generally sold for a para *. When they are ornamented, however, with a gilt border, painted with golden flowers, enamelled or set with precious stones, one of them will cost sometimes two, three, and even four piastres †.

X. *A singular Phenomenon respecting Snow, some of which of a red Colour was found on the Alps. By* M. DE SAUSSURE. *From* Voyages dans les Alpes. *Vol. III.*

WHEN M. de Saussure explored mount Breven, for the first time, in the year 1760, he found in several places on a declivity snow still remaining, and was not a little surprised to see the surface of it, in various parts, tinged with a very lively red colour. This colour was brightest in the middle of such spots as had their centres more depressed than the edges, or where different planes covered with snow seemed to be joined to each other. When he examined this snow more closely, he remarked that its redness proceeded from a very fine powder mixed with it, and which had penetrated to the depth of two or three inches, but no farther. It did not appear that this powder had come from the higher parts of the mountain, because some of it was found in places at a considerable distance from the rocks and much

* The value of a para is about three farthings.

† A piastre is equal to about half-a-crown.

lower

lower down; and it appeared alſo that it had not been conveyed thither by the winds, becauſe it was not diſpoſed in ſtripes or in the form of radii. The moſt probable conjecture therefore was, that it was a production of the ſnow itſelf, or the remains of its partial melting ſuſpended at its ſurface as in a filtre when the water paſſed through it. What ſeemed to favour this conjecture ſtill more, was, that the colour at the edges of the hollow places where little water had ſunk down was extremely faint; and, on the other hand, ſhewed itſelf ſtronger in thoſe parts where the greateſt quantity of water ſeemed to have penetrated.

M. de Sauſſure took a tumbler full of this ſnow, as he had no other veſſel with him, and held it in his hand till the ſnow melted, when he ſoon ſaw the red duſt depoſit itſelf at the bottom. Its colour then did not appear ſo dazzling as before, and when dry it loſt it entirely: it decreaſed alſo in quantity, ſo as almoſt to appear nothing.

Next year M. de Sauſſure aſcended the Breven, and found on it a quantity of the ſame kind of red ſnow, ſome of which he ſqueezed cloſely together and put into a large handkerchief, but before he got home it was entirely diſſolved by the heat of the ſun. It was not, however, on the Breven alone that he diſcovered ſnow of this kind; for he found of it on all the high mountains of the Alps, about the ſame ſeaſon of the year, and in ſimilar ſituations; ſo that he was much ſurpriſed that authors who had written reſpecting the Alps, ſuch as Scheuchzer, had made no mention of it. It is, indeed, true that it is found only in hollows, where the ſnow lies deep, and at a ſeaſon of the year when the melting of it has proceeded to a certain degree; for, when none of the ſnow or when very little of it has been melted, the duſt is then in too ſmall quantity to attract the eye; and if the melting has proceeded too far, the whole of the powder has paſſed through with the water, and it becomes equally inviſible. Beſides, towards the end of the melting, a great many foreign particles and impurities, conveyed thither by

 the

the wind, are mixed with it, so that its colour is no longer distinguishable.

In the year 1778, when M. de Saussure was on mount St. Bernard, he found a great deal of the same kind of snow. He collected as much of it as he possibly could; and Mr. Murrith, an experienced naturalist, collected of it also; so that they were enabled to make some experiments. On account of its great specific gravity, M. de Saussure treated this red powder as an earth, first with distilled vinegar, but he employed so little that he had no result. He then boiled it in the muriatic acid, and obtained a solution, which, when carefully distilled and filtred, had so brown a colour that he was quite at a loss respecting the nature of this substance. He therefore applied it to the blow-pipe, and observed that it inflamed with a smell like that of burnt vegetables.

This experiment induced M. de Saussure to digest 40 grains of the powder in spirit of wine; and having filtered the solution, he found that the residue weighed 7 grains less: the spirit of wine had become of a golden yellow colour. He then distilled it in a balneum mariæ, and the spirit of wine came off perfectly pure. An oily transparent matter of a golden brown colour, which by the warmth of the balneum mariæ had not become dry, remained at the bottom of the retort. This oily matter had a smell like that of wax, which it emitted also when burning. The deposit, which the spirit of wine had not dissolved, was, in regard to its extractive part, also inflammable; and the ashes which remained after it was burnt, though they did not seem alkaline, were fused by the blow-pipe into a porous kind of greenish glass.

These experiments seem to prove that this powder was a vegetable substance, and probably the farina of some flower. M. de Saussure was acquainted with no plant in Swisserland that produced red farina in such abundance as to tinge the snow of the Alps red; especially when it is considered that a great deal of it must be lost before it can reach the spots where

where the red ſnow is found. But the action of light, perhaps, may firſt give it its red colour; and in regard to its ſpecific gravity, that is not ſurpriſing, as by its long continuance on the ſnow it muſt, on account of the repeated ſlow meltings, receive ſuch an accumulation of particles as to become denſe and heavy.

M. de Sauſſure communicated his diſcovery to M. Bonnet, who adviſed him to examine the powder with a microſcope, in order to ſee whether it exhibited the appearance of the farina of flowers. He did ſo with the greateſt care and the beſt glaſſes, but he could not diſcover the leaſt regularity in its form.

Though M. de Sauſſure found this powder in different places on the Alps, he however aſks, whether it be very common, and whether it be found on the high mountains in different countries and different climates, ſuch, for example, as the Cordilleras? Theſe queſtions deſerve certainly to be examined; and though it be probable that this powder conſiſts of the farina of flowers, it is not altogether impoſſible that it may be an earth ſeparated by the ſnow itſelf, and poſſeſſing ſome inflammable properties called forth by the immediate action of the light and heat of the ſun, which ſhines with ſo much livelineſs in the pure air of theſe elevated regions.

XI. *Deſcription of an Apparatus propoſed to be applied to* M. KLINGERT's *Diving Machine, to enable it to be uſed at greater Depths than it otherwiſe could.*

SOME doubts having occurred to the inventor of the diving machine, deſcribed in our laſt Number, reſpecting the practicability of employing it at very conſiderable depths, he was induced to propoſe an additional apparatus to render it more extenſively uſeful. The deſcription of this propoſed improvement we ſhall give in his own words: "Suppoſing it it possible," says he, "to proceed to the greatest depths with the before-described machine, difficulties may still arise on account of the great length of the pipe; for it may be asked, Can the diver breathe long when the column of air is of such a length? I have found that it is difficult to breathe long through a pipe of a hundred feet, and half an inch in diameter; that the breast soon becomes fatigued; and that it is much easier to breathe through a pipe of half that length. Though a greater diameter may in part obviate this difficulty, so that the diver can breathe with more ease, yet another question arises: At the depth of a hundred feet and more, is it possible for the diver to manage such a long tube conveniently, as it must meet with resistance according to particular circumstances, and as by its length it must acquire considerable weight? How would he manage when he wished to rise again to the surface? and at such a depth could he make a signal for that purpose, and with sufficient quickness? On account of these questions I turned my thoughts to another machine, to be used in necessary cases with the former, and I hope the one I mean to propose will be found worthy of some notice.

"The figure (Plate III.) represents the machine, which consists of a hollow cylinder, terminating in two hollow truncated cones. It is constructed in the same manner as casks, and made exceedingly strong. In order that the wood may be rendered water-tight, it is daubed over on the outside with any proper varnish or cement.

"By means of the interior construction of this machine a man can descend to a great depth in the water, and live and move freely without a pipe to supply him with atmospheric air, because, being placed on a stage without the machine, and furnished with a harness and pipe like that before described, he can obtain air from the space within it, which contains 58 cubic feet. He may, therefore, remain under water two hours; descend from the stage at pleasure, move about with freedom, and, by means of the machinery within,

within, rise and descend when he thinks proper, as will appear from what follows :

" Those who have made experiments with air will not doubt that 50 cubic feet of it are sufficient to maintain the life of a man for two hours ; and the possibility of ascending and descending at pleasure may be thus explained :

" As this machine contains such a volume of air that it is lighter than water, it will require a considerable weight to make it sink below the surface. That as little, however, as possible of the space destined for containing air may be lost, lead may be employed, in the inside of the machine at *b*, sufficient to make it sink so far that a cubic foot of it only shall remain above the surface of the water. An additional weight then of 100 pounds will not only depress it below the surface of the water, but make it sink even to the bottom.

" But the same thing may be effected without weights, by lessening the volume of the contained air. This is done by means of the piston *c*, which fits closely into the cylinder *d*, and which, by means of the rack *e*, the pinion *f*, the wheel *g*, and the endless screw *h*, together with the winch *i*, can be moved either upwards or downwards.

" The machine, however, must not only be strong and durable, but be constructed according to the depth to which it is destined to descend and the pressure on the piston, that a man at such a depth may have sufficient strength to depress it by means of the winch, and thereby to enlarge again the volume of air. It will readily appear that, by raising the piston, the machine must sink to the bottom ; and that, by depressing it, the machine must again ascend ; as was proved by a small model which I made for that purpose.

" If a machine be constructed on a large scale, according to the proportions exhibited in the annexed figure, it will be found, by calculation, that, if we estimate the friction of the piston, when made water-tight, at 200 pounds, and that of the wheel-work at 300, though it may perhaps not be so much, the winch at the depth of 120 feet will not require a force

force of 40 pounds. If the diameter of the piston, however, be lessened, and the cylinder, in order that it may have the same cubic content, be lengthened, and if a larger wheel be added to gain more power, something will be lost in regard to time; but it can be easily calculated to what greater depth the machine may be used, and how much the strength of a man can accomplish. The higher the machine is in proportion to its diameter, the more securely will it remain perpendicular in the water, and the less danger will there be of its being overturned; because the diver is then nearer the centre of gravity. That the same advantage, however, may be obtained with less expence, the wheel work, together with the cylinder and piston, may be omitted, and the machine constructed as far as the upper cover *o*; but it must be so furnished with hooks for ballast, that the diver, when he has previously screwed on the pipe fastened to the machine and placed himself on the stage, may hang on ballast, stones or other heavy substances, till it sink, and, by throwing them away, may again ascend at pleasure. The machine in this form is simpler; and, in my opinion, to be preferred to the construction with the piston, wheel and rack, which I shall endeavour to prove in as mechanical a manner as possible.

"The ends of the pipe *l m*, which proceed into the machine, are so applied that all the particles of air may gradually proceed through the lungs. Should it, however, after being used two hours, be no longer capable of supporting life, the diver must ascend with his machine, and be conveyed to the ship or boat attending him, by means of the rope fastened to the ring *n*. He must then screw off the pipe, open the top *o*, and, by means of a pair of bellows screwed upon the mouth-piece, expel the air from the machine, and blow into it sound atmospheric air for further use*.

* This is not an effectual way of removing the tainted air, which may be more simply, and at the same time completely effected, by immersing it, when open, under water: on the pouring out of which afterwards, the machine would be filled with atmospheric air. Edit.

"Two

"Two ſmall oars may be added to the ſtep or ſeat in order to make a few movements, and alſo an anchor or grappnel to faſten the machine to the bottom, that the diver may be enabled to walk about with the pipe at freedom, for the purpoſe of examining ſunk bodies, and diſcovering the propereſt method of raiſing them. For the greater ſecurity, in caſe any accident ſhould happen to the machine, an apparatus may be applied to the pipe, that the diver can leave the machine and riſe without it; which he might eaſily effect, by throwing away the weights ſuſpended from his harneſs, and by retaining between his body and harneſs a ſufficiency of air for aſcending. By theſe means he might leave the great machine, even if he were not acquainted with ſwimming. As ſoon as he roſe to the ſurface, he would obtain freſh vital air through the opening *g*. (*See Plate I. of the preceding Number.*)

"At *p* is a lantern, the uſe of which is to afford the diver light in the water; becauſe the ſolar light is prevented from penetrating to very great depths by the many foreign ſmall particles mixed with that fluid, and is therefore incapable of rendering bodies lying at the bottom of it viſible; and becauſe occaſions may occur when artificial light will be neceſſary.

"I have alſo prepared ſuch lanterns to be held in the hand; but, for particular reaſons, I muſt here abſtain from explaining their conſtruction, and only aſſure the public, on my veracity as an honeſt man, that they anſwer the intended purpoſe. A candle in theſe machines, which are very ſimple, will burn in every kind of air, in mines and pits, where all other lights are extinguiſhed. They contain a ſpace equal to a cubic foot; and the candle burns, without any new addition from without, for two or three hours: they endure all concuſſions of the air, and are deranged by no motion or working in mines. Their utility, therefore, in other reſpects may readily be conceived. I ſhall not fail, however, at another time, to make them publicly known, as well as all the previous circumſtances which led me to the diſcovery.

XII. *Singular Inſtance of the Attachment of Birds of Prey to their Young. By* M. Cronstedt. *From* New Tranſactions of the Royal Academy of Sciences at Stockholm, *Vol. X.*

MR. Cronſtedt reſided ſeveral years on a farm in Sudermania, near a ſteep mountain, on the ſummit of which two eagle-owls (ſtrix bubo L) had their neſt. One day, in the month of July, one of the young owls having quitted the neſt was caught by ſome of his ſervants. This bird, conſidering the ſeaſon of the year, was well feathered; but the down appeared here and there between thoſe feathers which had not yet attained their full growth. After it was caught, it was ſhut up in a large hen-coop, and next morning M. Cronſtedt found a young partridge lying dead before the door of the coop. He immediately concluded that this proviſion had been brought thither by the old owls, which no doubt had been making ſearch in the night-time for the loſt young one, and might have been led to the place of its confinement by its cry. This turned out to have been actually the caſe; for M. Cronſtedt found that the ſame mark of attention was repeated every night for fourteen days. The game which the old ones carried to it conſiſted chiefly of young partridges, for the moſt part newly killed, but ſometimes a little ſpoiled. One time a moor-fowl was brought to the young owl, ſo freſh that it was ſtill warm under the wings: a putrid ſtinking lamb was alſo brought. M. Cronſtedt ſuppoſes that the ſpoiled fleſh had already lain a long time in the neſt of the old owls, and that they brought it merely becauſe they had no better proviſion at the time. He and his ſervant tried to watch ſeveral nights, in order that they might obſerve through a window when this ſupply was depoſited; but their plan did not ſucceed, and it would appear that theſe owls, which are very ſharp-ſighted, had diſcovered the moment when the window was not watched, as food was found to have been depoſited for the young before

the

the coop that very night. In the month of Auguſt this care ceaſed; but that period is exactly the time when all birds of prey abandon their young to their own exertions. It may be readily concluded, from this inſtance, how much game muſt be deſtroyed by a pair of theſe owls during the time that they rear their young. This obſervation is applicable to the whole race of owls, in general; and theſe may be conſidered therefore as the moſt deſtructive of all the birds of prey. As the eatable-birds of the foreſt repair chiefly in the night-time to the fields, they are particularly expoſed to the acute ſight, ſmell, and claws of theſe birds of the night; and even the ſwift-footed hare ſeldom eſcapes them.

XIII. *A ſhort View of the Mitchillian Theory of Fever, and of Contagious Diſeaſes in general.*

CERTAIN exhalations from marſhes and ſwamps, and from collections of putrefying vegetable and animal ſubſtances, induce diſeaſes attended with different degrees of malignity, according to circumſtances. There is a great ſimilarity at leaſt in the diſeaſes induced by the exhalations from marſhes and from putrefying ſubſtances: it ought to be ſo; for the noxious quality of the former is in conſequence of their containing the latter; and hence ſuch diſeaſes, though improperly, have been called putrid.

What is the peculiar ſubſtance, or what the ſubſtances in theſe exhalations that cauſe what are termed contagious diſeaſes? What the mode of action? Animal and many vegetable ſubſtances, eſpecially thoſe which contain gluten, give ſimilar products when decompoſed by the putrefactive proceſs.

Can hydrogen gas be the deleterious product? No—its baſe combined with different ſubſtances makes a great part of our aliment: with carbon it forms fat—with oxygen, water—with azote, the volatile alkali (ammonia), ufed as a medicine.

Carbonic acid gas cannot poffefs a contagious quality, for it is continually generating where its effects would be moft hurtful—in the lungs, from whence it is conftantly emitted by expiration. We fwallow it in great quantities in beer and other fermented liquors; and, combined with hydrogen gas, it may, as has been proved by the Englifh pneumatic phyficians, be taken in large dofes as a remedy for different difeafes.

Azotic gas forms nearly two thirds of the common atmofphere we breathe: its bafe united to other fubftances compofes a great portion of our food. Oxygen gas forms the other third—without it we cannot live.

Such gafes therefore may be *mixed* with each other, and yet not be the caufe of contagion. Where then is it to be fought? In fome *chemical union* between two or more of them, or their bafes, effected, by the operation of fome caufe, during their feparation from the organifed body of which they formed a part, by the procefs of putrefaction.

Permanently-elaftic fluids owe their gafeous form to a chemical union of caloric with their refpective bafes. When this union is once effected, two gafes may be mixed or blended together, as oil with water, or wheat with barley; but no chemical union can be effected between them, the attraction of the bafe of each for caloric being ftronger than that of the gafes for each other. When the affinity of their bafes for each other is ftronger than for caloric, a chemical union of the bafes may take place; but in that cafe the caloric is fet at liberty, and the product, inftead of being gafeous, is concrete, as when ammoniacal gas is prefented to carbonic acid gas.

But if the bafes act on each other before either be faturated with caloric, a chemical union may be effected between them: thus azote and oxygen will yield the nitrous acid.

acid. If caloric, as a third principle, unite itself, so as to saturate the oxygen and azote at the moment of their extrication, not to each respectively, but as entering chemically into union with each other, the result will be a gas holding the three ingredients chemically united, and consequently possessing very different properties from a mixture of oxygen gas with azotic gas; for, in the latter case, the base of each having been previously saturated with caloric, both the gases by that means have been put into a state that prevents the possibility of a chemical union taking place between them.

When a *mere mixture* of oxygen gas and azotic gas (atmospheric air) is inhaled into the lungs, the animal powers exert such an action on the oxygen gas as to effect a separation between the oxygen and caloric, applying each to the purposes intended by nature; while the greater part of the azotic gas is respired undecomposed, mixed with the carbonic acid gas that has been generated by the union of a portion of the oxygen gas with carbon furnished by the animal, and with moisture formed by a portion of the base of the oxygen gas with hydrogen, the caloric of that portion having gone to the supply of the animal heat. But if a gas composed of oxygen and azote *chemically combined* with each other and with caloric, be diffused through the atmosphere inhaled, a substance is received into the lungs possessing very different chemical properties from common air; for, though the component principles be the same, being combined in a very different manner, it must possess a very different mode of action upon the animal. In fact, it may be taken into the system in its combined state, where, meeting with principles which possess a stronger affinity for some of its constituent parts than they do for each other, it may be decompounded; while, by the same operation, the animal fluids, or solids, or both, are themselves decompounded, by parting with one or more of their principles which enter into the new combination.

Where ſuch a noxious gas abounds, it is no wonder that peſtilential diſeaſe ſhould be the conſequence, eſpecially if it ſhould prove miſcible in water, for then it will be taken in with the food and drink, and may even be abſorbed by the ſkin, as well as by the noſe, pallate and lungs.

The nitric acid, which is compoſed of oxygen and azote, poſſeſſes very different properties from atmoſpheric air, which is a mixture of theſe two each previouſly combined with caloric. It would be juſt as fair reaſoning to ſay that, their baſes being the ſame, they muſt poſſeſs the ſame properties, as to infer that the noxious gas above mentioned ſhould poſſeſs the ſame properties with atmoſpheric air, becauſe compoſed of the ſame ingredients.

Oxygen and azote, by certain operations of nature, enter into combination with other elements to form organiſed bodies. By this proceſs they are put into a ſituation which enables them to form a new union as ſoon as the laws by which the organiſed ſtructure maintains the harmony of the complex combination, ceaſe to exert their influence upon it. New affinities then begin to operate, and that ſpecies of decompoſition ſo well known by the name of putrefaction is the immediate conſequence. The oxygen and azote, during their extrication from the putrefying ſubſtance, may come within the ſpheres of each other's attraction, without entering into an intermediate ſtate of gas by union with caloric: and in this way it is probable ſome modification of nitrous gas, or the nitrous acid, is formed, according as caloric enters or not as a third ingredient into the compound.

As this gas, which the ſupporters of the preſent theory conſider as the matter of contagion, according to them, always owes its origin to the putrefaction of animal and vegetable ſubſtances, they have given it a name expreſſive of that origin. They aſſume the word *ſepton* to expreſs the radical of the nitrous acid, and derive it from *σηπω*, *putrefacio*; whence comes ſepton, *putridum*; and propoſe that the combinations

formed

formed from the base of the nitrous acid may have new terms in the nomenclature, and be arranged in the following order:

Septon, for azote or nitrogen
Septous gas, for azotic gas
Gaseous oxyd of septon, for dephlogisticated nitrous air*
Septic gas, for nitrous gas
Septous acid, for nitrous acid
Septic acid, for nitric acid
Septat, septite—for nitrat, nitrite, &c.

By insisting that the nitrous acid is of animal derivation, or from vegetables possessing the same principles, the Mitchillians only mean, that nature effects the decomposition of azotic gas by the operation of those laws which she employs in forming organised bodies; that oxygen (not in combination with caloric) enters into the composition, and that during the destruction of such bodies these principles unite with each other. By the affinity the product has for the vegetable alkali, which, or the principles that form it, is extricated from decaying vegetables, it joins it wherever it can find it, and produces nitre, the grand source from whence the nitrous acid is made.

To prove this position, the works of those who have wrote on the production of nitre, and the nature of the soils where it is produced in the greatest abundance, are examined, and from them the fact is endeavoured to be established, that the putrefaction of organised substances is an indispensible requisite. Another fact is pointed out from the same source, and from medical writers, namely, that the neighbourhood of such soils is extremely unhealthy, especially at particular seasons of the year, when circumstances, in the first place, are such as to favour quick putrefaction, and in the second, to present the greatest number of obstacles to the septic (nitrous) gas, being taken out of circulation by being neutralised.

* So named by Dr. Priestley, because it can maintain combustion.

If ſuch be the fact, it offers a ſolution of the queſtion, Whence jails, hoſpitals, ſhips, and other crowded places, become infected with noxious vapours?—The animal exhalations, excretions, &c. go through the putrefactive proceſs in the ſame way that dead animal ſubſtances would, and the products are the ſame. One of them, the gaſeous oxyd of ſepton, being miſcible in water, lodges itſelf in the damp walls, where, after it has ſaturated ſuch of the ſubſtances it meets with as have affinity for it, it keeps accumulating, till ſome circumſtance, as hot weather for inſtance, drives it out with the evaporating moiſture, in ſuch quantity as to infect the atmoſphere.

That combination of ſepton (azote) with the acidifying principle which produces the gaſeous oxyd of ſepton, is not however conſidered as excluſively the only proportion of the ingredients that produce contagion. There are an infinity of gradations in the proportions in which theſe principles may be united, and yield a contagious fluid—the vapours of the nitric acid itſelf are not excepted. Theſe peſtilential fluids are conſidered as being always, even in their weakeſt form, ſomewhat of ſtimulants. In many inſtances moſt violently ſo. Though their operation is modified, when in a dilute form they impede reſpiration, or nauſeate the ſtomach, as they then bring on a diminution of action and energy amounting in the cold ſtage to a ſtate of direct debility: when applied in great quantity and force, they kill inſtantly; when in leſs quantity, they produce an anomalous diſeaſe, of the form of which Chiſholm's caſes preſent inſtances; when in a weaker ſtate, a common contagious catarrhal affection may be the conſequence; when inhaled in a form yet more diluted, a remitting or intermitting fever may be the diſeaſe induced, of the form of quotidian, tertian, or quartan, or any of their varieties; or the remitting may be called jail, hoſpital, ſhip, camp, army, yellow, putrid, or bilious, malignant, peſtilential, miliary, petechial, ardent, flow, continued, continual, dysenteric, contagious or infectious, according to the circumstances that may occur in the progress of the disease.

" The main difficulty left is to account for the cold fit of a regular tertian. This stage of fever I believe to depend upon impeded respiration, and the impeded respiration to depend upon the vitiated quality of the air taken into the lungs; or in some slighter cases, where the stomach is originally thrown into a disordered state, the lungs, by association with that organ, are thrown into disorder too, and for a time perform their functions but imperfectly.

" Thus I presume it is that the impeded state of respiration is attended with a smaller evolution of heat and oxygen in the lungs, and consequently with more or less diminution in the circulation of the blood, and a proportionable degree of chilliness and coldness throughout the body. The duration and degree of the cold fit will correspond to the continuance and power of the causes disturbing the pulmonic organs, either by acting upon them directly or indirectly through the intermedium of the stomach.

" From the small quantity of heat and oxygen communicated to the blood in the lungs, and the consequent slow and feeble circulation of the blood, can the shrinking, paleness, tremors, coldness, debility, &c. &c. be sufficiently explained, as the constitution is now deprived of its two chief stimulants.

" But why does not the continued operation of the vitiated air upon the lungs, or the associated condition of the lungs with the stomach, go on in an increasing series even unto death? The power of our constitutions to become familiarised to the action of noxious causes, is evinced by the innocent operation of poisonous substances, which, by frequent repetition, grow gradually habitual, and by custom lose their primary operation. This disposition to become familiarised to vitiated airs, is apparent in the inhabitants of Africa, who are so seasoned to the air and climate they live in, that it excites no diſturbance at all in their conſtitutions, while ſtrangers fall victims in the greateſt abundance. Now, common intermitting paroxyſms are inſtances of temporary ſeaſonings, which the conſtitution experiences, of a kind quite analogous to what is perpetual with the Guinea negroes.

"The cold fit ſometimes does terminate in death; and this happens when the conſtitution cannot acquire the habit of enduring the noxious cauſe with impunity. In the generality of caſes, however, the ſtimulus of the infectious gas loſes its power to operate before the conſtitution is debilitated to death; and as ſoon as it becomes, for this time, ſo much accuſtomed to the vitiated air, as no longer to be diſturbed by its preſence, the cold fit ends. The length and violence of the cold fit will thus be, *cæteris paribus*, in a compound ratio of the impediment given to the reſpiration by the infectious gas, and the facility with which the conſtitution accommodates itſelf to its action: if three perſons then inhabit one houſe, it is poſſible that one may become ſo quickly accuſtomed to the air as to have no diſtemper; a ſecond may have a moderate diſeaſe of but a few fits; while the third, poſſeſſed of a conſtitution not eaſily moulded to a new habit, may be incommoded by a violent and obſtinate malady.

"In every paroxyſm of an intermittent, the infection thus wears itſelf out; but this is only a temporary reconcilement of the body to its action; when, after a repetition of fits, the diſorder becomes milder and milder, and after a while wholly ceaſes. This is a caſe of laſting reconcilement; and in this way may a large portion of ſmall intermittents cure themſelves, while the credit is given to the bark! This power of habit daily does wonders, and labours more effectually for the good of the ſick than bark, opium and antimony put together.

"The attack of theſe cauſes being thus for a time overcome, reſpiration grows free, full, and frequent; becauſe there

there is now a greater appetency in the conſtitution for heat; more vital air is decompounded in the lungs; and more ſtimulus is applied, by means of the increaſed heat and oxygen now in the blood, to the heart and arteries: theſe ſtimuli operate more powerfully on account of the accumulated excitability of the body; and a degree of excitement is thence induced, which ſometimes ends in death, ſometimes cauſes delirium, and in almoſt every caſe exceeds the healthy temperature.

"The duration and violence of the hot ſtage will be, *cæteris paribus*, in a compound ratio of the excitability accumulated in the cold ſtage, and the heat and oxygen evolved in the hot one. When the excitability is exhauſted by the operation of the ſtimuli, the violence of action will ceaſe, and the body grow cool.

"The doctrine of intermitting fever, then, is briefly this: the vitiated atmoſpheric fluid, by interfering with the pulmonic action, brings on the cold ſtage, and would continue the ſame until its termination in death, did not the conſtitution in the mean time acquire ſuch a habit as to gain a temporary inſenſibility to its action. This habit being induced, the cold ſtage abates by reaſon of the ſtate of direct debility into which the body had been brought; anxiety continues, and, by the quickening of reſpiration, heat and oxygen are ſet looſe in the lungs, and becoming incorporated with the blood, now warm and ſtimulate every part with more than uſual power, and occaſion the phænomena of the hot ſtage, which terminates as ſoon as the accumulated excitability of the ſyſtem is exhauſted.—The ſweating ſtage follows of courſe, as in other caſes of the ſubſidence of violent action: for, after a time, the exhauſted excitability of the animal ſyſtem allows exceſſive action to go on no longer; the reſpiration grows more moderate and eaſy; the heart beats with leſs frequency and force; the arterial contractions are alſo more ſlow and health-like; and, as the arterial contractions relax, the hydrogen and oxygen of the blood

blood now run together in the extreme veſſels of the ſkin, and form the moiſture which bedews the ſurface; and this afterwards flying off by evaporation, cools by degrees the whole body down to its ordinary temperature: and, as the arterial extremities of the reſt of the body become dilated by the ſubſidence of excitement, the other ſecretions, which had been generally ſuſpended during the fit, now return as before: after this, the conſtitution, ſo far accuſtomed to the breathing ſuch an atmoſphere, regains its former vigour and functions, as far as the exerciſe induced and functions injured during the ſeveral ſtages will allow.

"The interval between one fit and the ſucceeding one, will be proportionate to the duration of the habit of reſiſtance acquired. Some perſons thus experience but one fit, and all is over; for, under the ſame circumſtances they are never invaded by a ſecond. Others ſuffer two fits, or a ſucceſſion of fits, and after a while become ſo accuſtomed to the ſtimulus, that, if always applied in the ſame degree of ſtrength, its effect is no longer felt upon the body: in other inſtances again, ſo hard is it for the conſtitution to be moulded into a ſettled habit of oppoſition, that after enduring a great number of invaſions, it becomes at length enervated and worn down ſo much as finally to die exhauſted.

"The ſpecies of fever, whether quotidian, tertian, &c. will depend upon the readineſs or quickneſs wherewith the offending cauſe gains a new aſcendancy over the body, or breaks the habit. And to the mobility of the body, or eaſe with which the habit is broken, is to be aſcribed, as well the frequency of the returns, as the duration and ſeverity of the paroxyſms.

"The anomalous caſes of fever, which have puzzled phyſicians to explain, and noſologiſts to arrange, are thus very naturally accounted for; ſince, according to the variation of the cauſe, as the noxious atmoſphere may thicken or diſperſe, will be the variety in the effect produced; and as there may be be infinite gradations of the deleterious cause, there may be endless varieties in the morbid effect.

"And to this principle of the human constitution, I believe, may be referred all the febrile ailments from the most trifling intermittent to the more serious remittent, and the solemn form of continued fever.

"Hence further may it be understood how a succession of fits, long continued, may dispose the constitution to a repetition of fits, even when the morbid cause is away: for though there may be a habit of insensibility produced to the vitiated airs, yet a habit may, in the mean while, be established in the bodily motions of falling periodically into regular trains of action, even when the original cause is withheld. Here then will be produced a habit of having paroxysms depending on the particular inward state of the moving fibres, after the manner of temporary seasonings; while, at the same time, there is a habit formed of resisting the active causes (vitiated air) altogether, or of obtaining a permanent seasoning as to them.

"The cold stage of a paroxysm is a state of direct debility, induced by the vitiated air breathed operating to subduct heat and oxygen from the body; and its termination is by the stimulus of the vitiated air being for that time worn out. The hot stage, which begins as soon as the temporary seasoning is induced, is a state of excitement brought on by the heat and oxygen now operating upon the accumulated excitability with additional force.—The sweating stage is formed after the subsidence of the excessive action of the body, and the consequent enlargement of the diameters of the vessels, whereby sweat is formed by the combination of hydrogen and oxygen, and the other secretions proceed again, as usual, in the several glands.

"The length of interval between the paroxysms depends upon the strength of habit acquired.

"The frequency of their occurrence will be proportioned to the facility with which a temporary habit is broken or gives way.

"The cold ſtage is the moſt dangerous; and perſons dying in it, die of the direct debility induced by the vitiated atmoſphere they reſpire.

"The hot ſtage is leſs dangerous, and perſons who die in it expire in a ſtate of indirect debility. But, according to circumſtances, death may happen in both the cold and hot ſtages.

"The ſweating ſtage is a mere conſequence of the cooling of the body, after the preceding heat and excitement of it."

Our limits will not permit us to detail, at length, all the arguments that have been brought forward in ſupport of this theory, by its author Profeſſor Mitchill of New York, and by thoſe medical gentlemen in America who have embraced his opinions. We have however endeavoured to give ſuch a conciſe yet accurate account of the theory, and the grounds on which it is ſupported, as may enable thoſe of our medical readers, who have not ſeen the American publications on the ſubject, to form ſome opinion reſpecting it. We give no opinion of our own—that does not belong to our province. It will not however eſcape the notice of medical men, that daily obſervation preſents ſome facts which, on firſt view at leaſt, do not appear reconcileable with this theory. Copper-plate engravers, in the courſe of their buſineſs, are often obliged to breathe an atmoſphere loaded with ſeptic (nitrous) gas, without appearing to be more liable to contagious diſeaſes than other men; and, to mention no other fact of this kind, it has been proved, by the experiments made on board the Union hoſpital ſhip by deſire of the Lords Commiſſioners of the Admiralty, of which we gave an account in our laſt Volume, page 68, that the fumes of the nitric acid are not only a cure, but an antidote againſt contagion. A. T.

XIV. *De-*

XIV. *Description of a Machine for drawing Bolts in and out of Ships. Invented by* CAPT. WILLIAM BOLTON *of the Navy. From* Transactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

THE gold medal was voted to Captain Bolton for this contrivance, a model of which is preserved for the use of the Public in the Society's repository.

A A A A A A (Plate IV.) is the frame of the machine. B, a cylindrical tube, having a female screw in the inside. C, a wheel with teeth attached to the cylinder B. D, an endless screw adapted to the wheel C. E, handle of the winch. F, the bolt drawing out. G G, blocks to support the frame. H, a hollow piece of steel, having on its outside a male screw, whose threads work within the female screw in the cylinder B. To this piece of steel the bolt is to be riveted. I, a semicircular piece of steel, which is to be introduced into the notches on H, when a similar notch has been cut in the head of the copper bolt, which by this means is prevented from turning in H, while drawing. K, the bolt, as prepared to receive the machine. L, a steel bar, somewhat smaller than the bolt to be drawn, having at one end a male screw, A, and at the other end another male screw that fits into the female scraw in B. M, a section of a male screw, having a square hole larger than the bolt. N, a bolt with a male screw at one end ready to be drawn in.

The machine, of which a plate is annexed, consists of a frame supporting a cylindrical female screw tube. On this tube is mounted a wheel with teeth adapted to an endless screw fitted to the frame, and worked by a handle.

To draw the Bolt out.

The head of the bolt must be cut off, and a hole made in the timber big enough to receive the male screw H, which is put over the bolt: a ſlit is then to be made, either by a ſaw or cold chiſſel, in the head of the bolt, to receive the key I, and which correſponds to the ſlit in H: the bolt head is then to be riveted as firmly as poſſible upon H: the cylindrical tube, B, is then to be ſcrewed on, turning the whole machine round till it can be done no longer, when the endleſs ſcrew is to be uſed. If the machine is of a proper ſtrength, and the riveting well done, the power is ſuch as to extract the bolt or break it, but generally it will be drawn out uninjured.

To draw Bolts into Ships.

It will be neceſſary to have a bar, L, which I recommend to be made of ſteel, long enough to paſs from the inſide to the outſide of the ſhip, and ſomewhat ſmaller than the copper bolt intended to be drawn in. This may be called a conductor. On one end ſhould be a male ſcrew, *a*; the bolt to be drawn in ſhould be tapped at one end to receive the male ſcrew, *a*, on the conductor, and at the other end ſhould be another male ſcrew that fits into the female ſcrew in B; after which the operation is the ſame as drawing a bolt out, and the machine ſhould be applied accordingly. When the bolt arrives at its deſtined place, it may be ſecured on the inſide by a nut, which is as good a way of faſtening as clinching, and much more expeditious.

This machine, though only of the height of eighteen inches, will draw bolts in or out of any length; for, after the bolt has riſen to the top of the tube, it will only be neceſſary to ſcrew the machine back, and follow up the work with blocks of timber, as repreſented in the drawing.

Note. If the upper part of the hole in H be made ſquare, larger than the round hole as ſhewn at M, and the head of the bolt riveted into it, it will do away the neceſſity of the key, I, render the machine leſs complicated, and ſave much time and trouble.

XV. *Description and Use of* C. GUYTON's *Eudiometer. From* Journal de l'Ecole Polytechnique, *P.* 11.

CHEMISTS and Philosophers have long wished for an eudiometer capable of shewing exactly the quantity of oxygen gas mixed in any other gas. Berthollet has proved, in his Lectures at the Normal School, that the eudiometer of Scheele, which he justly considers as the best, has still great defects, as the absorption requires several hours, and as towards the end there is a decomposition of water, and consequently a disengagement of hydrogen gas, which occasions uncertainty respecting the quantity absorbed.

This induced me to seek for some substance which in a convenient manner might immediately give a more accurate result than nitrous gas, hydrogen gas, phosphorus, and a mixture of sulphur and iron, the only substances which, as far as I know, have been hitherto employed for that purpose.

Sulphure (sulphuret) of potash appeared to me fit to be tried under this point of view. I was well aware that at the ordinary temperature it is susceptible only of a combustion still slower and more insensible than a moistened mixture of sulphur and iron; but I presumed that, if the temperature were raised by applying a small taper, it would be sufficient to put in action the affinity, and to determine rapidly an absorption which would not then be affected by any foreign cause. The effect fully answered my expectation; so that the question then only was to determine the apparatus necessary to form this new eudiometric instrument. I thought that an inversed retort would unite simplicity, convenience, and every advantage that could be desired. The following is a description of it.

AB (Plate V.) is a small glass retort with a long neck, and capable of containing from 12 to 15 centilitres*. One must be chosen so much bent that, when the neck is placed vertically, the bulb may form in its lower part a cavity con-

* About eight cubic inches.

taining

taining the matters introduced into it. The extremity of the neck is ground with emery to fit air-tight at C into the glass tube C D, open at both ends, and 20 or 25 centimetres in length. F is a cylindric vessel—a common glass jar, into which the tube of the glass C D may be entirely immersed below the surface of the water.

When you wish to try any aeriform fluid in order to separate its parts, and discover the quantity of respirable air it contains, put into the retort two or three bits of sulphure of potash of the size of a pea; fill it with water, taking care to incline it to make all the air which might remain in the bulb pass into the neck; stop with the finger the orifice of the retort, and place it in the pneumatic tub, that the gas to be tried may be introduced in the usual manner. By inclining it again, alternately in different directions, all the water may be easily displaced, and the sulphure left remaining in the bulb.

Then place the retort vertically, and introduce the end of it into the glass tube C D, which must still be under water; and place below the bulb a small lighted taper. To preserve the retort in its position, a cover of wood, with an aperture for its neck to pass through, should be fitted to the jar.

The first impression of the heat dilates the gaseous fluid, so that it descends almost to the bottom of the tube, which has been disposed on purpose to receive it, and to hinder any part of it from escaping, which would be the case if the tube were not sufficiently long, and which would prevent the diminution from being accurately determined. As soon, however, as the sulphure begins to boil, the water ascends with rapidity, not only in the lower tube, but also in the neck of the retort, notwithstanding the application or even augmentation of the heat. If it be vital air absolutely pure, the absorption is total. In that case, to prevent the vessel from bursting, which might happen were it cooled too suddenly, the ascent of the water must be retarded, either by removing the taper, or inclining the retort, which will not hinder

hinder the abſorption to continue, while there remains gas proper for maintaining combuſtion.

If it be common air or vital air mixed with any other gas, you muſt, after cooling, meaſure the quantity of water which has entered the retort, and which will exactly repreſent the bulk abſorbed. You muſt not neglect to confine the remaining gas under the ſame preſſure, by immerſing the retort in the pneumatic tub, till the internal and external water be on the ſame level, before you cloſe the orifice by a ſtopper. This operation, very eaſy when you have graduated veſſels, may be made in common practice by means of a piece of paper cemented along the neck of the retort, and having traced out on it diviſions determined by experiment, and which may be covered with varniſh to defend it from the action of the water.

C. Chauſſier has conſtructed, for eudiometric experiments by phoſphorus, an apparatus ſomewhat different, compoſed of a long tube all of one piece, one end of which is bent and blown into a bulb, and having, as at *e*, a tubulure ſhut with a ſtopper after the water has been made to aſcend in the inſide of the tube to two-thirds of its height. This inſtrument would ſerve alſo for experiments with the ſulphuret of potaſh; but I muſt obſerve, that the execution of it is not ſo eaſy as on the firſt view might appear. Beſides, if the tubulure renders it very convenient for trying atmoſpheric air, the caſe is not the ſame in regard to other gaſes which cannot be introduced but by tranſmiſſion.

XVI. *On the Component Parts of Iron-ſtones, and how theſe in the manufacturing affect the Quality of Crude Iron. By* Mr. DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

IRON-STONES, though commonly denominated ores of clay, contain notwithſtanding a variety of mixtures, and may with propriety be divided into the following claſſes:

1. Iron-ſtone that has clay for its chief component earth, and this clay comparatively pure and free from ſand.

2. Iron-ſtone poſſeſſing lime for its chief mixture, and this lime alſo comparatively deſtitute of ſand.

3. Iron-ſtone that unites clay and lime, containing large proportions of ſilex; hence, for diſtinction's ſake, may be denominated ſiliceous iron-ſtones. I ſhall therefore, in naming theſe varieties, uſe the following terms as they are arranged in ſucceſſion. Argillaceous, calcareous, and ſiliceous iron-ſtones. None of theſe earths exiſt ſingly with the iron. All iron-ſtones contain a mixture of the three, in various proportions; from which ariſe the ſuppoſed variety of the qualities of crude iron, which each reſpective ſtone is ſaid to contain. There are ſome, however, which are compoſed of nearly the ſame proportions of clay, lime, and ſilex; and theſe commonly afford, when compared with themſelves, a ſimilar quality of crude iron.

Nature, in the formation of theſe ſecondary ores of iron, has invariably impreſſed characters upon them, eaſily to be developed: by which means their qualities, and the conſequent effects produced in the blaſt-furnace, may be accurately and diſtinctly prejudged. The ſource of this information is, the ſtudy of the nature of the united earths; by aſcertaining the quantity and proportion of which, we are enabled to pronounce exactly upon the quality of the iron likely to be obtained from the ore. We muſt not, however, conſider theſe characteriſtic features as a conſequence of the metal exiſting of a variety of qualities; but, *a priori*, we ought to conſider, that, as a conſequence of the nature and proportions of the mixture, the iron will be called into exiſtence in a ſtate more or leſs oxygenated or carbonated.

When iron-ſtones are ſaid to contain *good* or *bad* iron, the expreſſion ought to be underſtood, which by the bye is ſeldom the caſe, only as a comparative aſſertion, confined to local rules, and judged by certain fixed local ſtandards; into the account of which many things muſt be taken, which are frequently overlooked. At every iron-work, a certain proportion

portion of fuel, coaks or wood char, by weight, is underſtood to be ſufficient to ſmelt, and give principle to a determinate weight and quality of iron-ſtones combined together, in order that a certain quality of crude iron may be produced. In this caſe, ſhould a new iron-ſtone be ſubſtituted for one whoſe quality and effects are already known, and ſhould its application be productive of iron leſs carbonated than formerly, it would inſtantly be denominated a *bad* iron-ſtone, or an iron-ſtone containing bad iron—an aſſertion only true comparatively ſo far as it would affect the intereſt of the manufacturer, unleſs corrected by an addition of fuel, a change of the mixtures of ores, or a varied application of the lime-ſtone uſed as a ſolvent or flux. But this is no proof that the quality of iron, as it exiſts in the ore, is bad, ſince a larger proportion of coaks, or a change of mixture, which incurs no additional expence, can correct the evil. It rather furniſhes a demonſtration that the iron in all ores is the ſame; but that, in calling it into a metallic form, the quality is affected chiefly by the reduction of thoſe mixtures originally united with it.

As the quality of the fuel is improved in a direct ratio to the quantity of carbon which the coal contains, and its purity, hence ariſe the great variety of coaks uſed in ſmelting iron-ſtones; ſome of which will ſmelt, and give principle to the iron contained in double the weight of the ſame ores that others will. From this then may be deduced another proof, that *good* and *bad* iron are terms of comparative meaning only, confined to ſituation. Let it be conceived that a change of fuel oppoſite in its quality to that now mentioned was to take place; the ſame quantity of ore, which with the good coaks would have afforded metal richly carbonated, would now yield its produce in a partial degree, and that highly oxygenated—almoſt unfit for any purpoſe. The conſequences here entailed are the ſame, though they may be attributed to different cauſes; the former as derived from the hoſtile mixture of the ore, but the latter as ariſing from a deficiency in the quality of the coaks.

 Beſides

Beſides theſe two leading inſtruments of alteration in the ſmelting proceſs, inherent in and derived from the materials, good and bad effects may be produced from an unjuſt proportion and quality of the lime-ſtone, which is added, in order that the proper equilibrium may be reſtored, and the iron properly and beneficially revived.

Taking this then for a general principle, that the crude iron contained in all iron-ſtones is the ſame, and that it can be called into exiſtence as a metal of all the various degrees of carbonation, by regulating the proportion of fuel, and of the ſolvent; I ſhall proceed to mention thoſe mixtures which I have always obſerved determine the future quality of the crude iron.

1. Argillaceous iron-ſtone having fine clay as its chief component earth, lime in the next proportion, and both theſe nearly deſtitute of ſand; which, when properly torrefied, exhibits fibres on its internal ſurface, of a brown, dark-brown, or claret colour, running either in ſtreaks or radiated, and adhering tenaciouſly to the tongue, will afford, with a moderate proportion of coaks and lime-ſtone, iron of the fineſt quality, poſſeſſing ſtrength conjoined with an intimate degree of fuſibility.

2. Calcareous iron-ſtone, that which contains lime as its principal earthy mixture; holding clay in the next proportion, and both theſe comparatively unallayed (totally they never are) with ſand; which, when regularly torrefied, aſſumes a variety of ſhades generally lighter in the colour than the former claſs; which ſometimes, and ſometimes not, preſents internal fibres, and which adheres leſs tenaciouſly to the tongue; always contains iron, which can be revived, richly carbonated with a comparatively ſmall quantity of coaks, and with a trifling addition of lime. Under this claſs of iron-ſtones are found thoſe which produce iron of a fuſible nature, ſeldom connected with ſtrength, but valuable for its utility in fine caſtings, which require ornament more than durability. It is alſo from this ſource of mixture that I would trace the red ſhort quality of bar-iron. The

nature

nature impoſed upon crude iron in the blaſt-furnace by the development of its mixtures, moſt commonly accompanies it through all its ſubſequent ſtages of exiſtence as a metal.

3. Thoſe iron-ſtones whoſe component parts are nearly an equaliſed mixture of clay, lime and ſand, which torrefy with a ſlight degree of adheſion to the tongue, aſſuming a dark-red or browniſh colour, void of internal fibre, always afford, with the local proportion of fuel, iron of an intermediate quality for fuſibility and ſoftneſs, but generally poſſeſſing ſtrength in an eminent degree. Such iron is excellently adapted for the manufacture of great guns, mortars, and the large ſpecies of machinery. Its application to the purpoſe of bar-iron making, would alſo be attended with the moſt beneficial effects, poſſeſſing neither the extreme of fuſibility nor of infuſibility: it would greatly prevent, in the manufacturing, a tendency, which iron poſſeſſed of theſe extremes has, to become red or cold ſhort.

4. Iron-ſtones which unite a large proportion of ſand with ſparing proportions of clay and lime, which, upon being ſlightly expoſed to heat, exhibit maſſes of ſemivitrification, neither obedient to the magnet, nor adheſive to the tongue, having a refractory diſpoſition to part, and poſſeſſing a dark-blue or black colour, always afford, with the uſual proportion of fuel, crude iron of the worſt quality, either as to ſtrength or fuſibility. Such metal is commonly highly oxyginated, and brittle; incapable of being uſed alone for any melting purpoſe; and, when applied to the uſe of the forge, affords malleable iron, which poſſeſſes the cold ſhort quality.

Theſe are the four principal claſſes under which I have arranged our iron-ſtones, with regard to their tendency to afford their iron carbonated, poſſeſſing ſtrength, or otherwiſe, when ſmelted in the blaſt-furnace with a determinate quantity of fuel. As this claſſification is exactly analogous to the reſults obtained in the large way, it may ſerve as a ground-

 work

work to thoſe who may wiſh to attain a practical knowledge of theſe ores, ſo far as it relates to their manufacture.

It is however eaſy to counteract the natural tendency which every iron-ſtone has in this caſe, to afford its iron of a certain quality, and to make each of them yield crude iron of all the different degrees of fuſibility and ſtrength. Is it not obvious, that ſince the qualities of crude iron depend upon the mixtures and their kinds compoſing the ſtones, that if nature be aſſiſted by adding or ſubtracting from them in the blaſt-furnace, every quality of crude iron may be produced from the ſame iron-ſtone? I have ſeen moſt of theſe reſults determined in the large way, and the whole of them beautifully confirmed in the aſſay-furnace.

It remains with the preſent manufacturer to conſider whether it will be more his intereſt to reject ſuch iron-ſtones as are of difficult carbonation, or to apply the neceſſary additional proportions of fuel, capable of correcting the quality of ſiliceous iron-ſtones. Not ſo, however, to thoſe who may at ſome future period ſucceed him; neceſſity, at all times ingenious, aſſiſted by the increaſing light which ſcience daily ſheds over our manufactures, will deviſe the means of calling into profitable exiſtence the metal contained in all thoſe ores which may have fallen into diſrepute in the preſent day, or from which at this time it is thought impracticable to extract metal in the large way.

The uſual criterions by which iron-ſtone is judged, whether it be ſufficiently rich in iron for the purpoſe of ſmelting, are the following:

1. The degree of tenacity with which it adheres to the tongue after torrefaction: 2. Its colour: 3. The obedience to the magnet when pulveriſed: 4. By depriving of its iron a given weight of the ore, in contact with charcoal and fuſible earths in the aſſay-furnace.

The firſt and third of theſe methods are liable to great error. The adheſion to the tongue will be more in proportion

tion to the quantity of clay and its kind contained in the ſtone, than to its real contents in iron. Iron-ſtone may alſo be torrefied in ſuch a manner as to deprive its internal ſurface of this property; as it is only peculiar to the ſtone at a certain ſtage of torrefaction.

The influence which the magnet poſſeſſes over ſome ores of iron is no direct proof of the quantity of iron contained; as ſome ores which contain 15 parts in 100 are completely magnetic, while others again that contain 60 to 70 parts of iron in 100 are not in the ſmalleſt degree affected with this property. The magnetic teſt is more uſed to aſcertain the exiſtent ſtate of the metal, whether mineraliſed with an acid, combined with ſulphur or with oxygen, or exiſting in a diſengaged ſtate more or leſs metallic. No iron-ſtones which in their native ſtate contain their iron mineraliſed with oxygen, or in the ſtate of an oxyde, completely diſperſed through an intimate combination of clay, lime and ſilex, containing water, carbonic acid, and ſometimes concrete ſulphur, are obedient to the magnet till ſuch time as torrefaction has paſſed upon them, either expoſed to open air, or in contact with charcoal in cloſe veſſels. If this proceſs is continued for a ſhort time, the whole maſs will become obedient; but this affection will ſtill depend upon the relative quantity of concrete oxygen fixed with the iron. Individually, however, iron-ſtones are affected by the proportion of heat conveyed to them while torrefying. If the quantity communicated has been ſparing, ſo as not to have carried off all the water, carbonic acid, &c. the magnetic virtue will alſo be proportionally abſent: if the diſſipation of theſe ſubſtances has been complete, the magnet will poſſeſs an influence in the exact ratio of the quantity of oxygen which remains combined with the metal. Should it happen that a degree of heat capable of exciting fuſion is applied, the maſs will then rapidly loſe its magnetic obedience by an extra-fixation of oxygen; if driven ſo far as to make it exhibit a ſemi-vitrified appearance, this principle would be found to be entirely annihilated.

Although the colour which iron-ſtones aſſume in torrefying intimately depends upon the degree of heat preſented to them in the operation of burning, yet, by regulating this agent in a proper manner, an accurate knowledge may be formed, not only of the probable quantity of iron, but even of its tendency to become carbonated in ſmelting. The expulſion of the water and acid leaves the combined earths more expoſed to determination. The ſmall ſpecula of ſilex are diſtinctly diſcerned; adheſion to the tongue develops the preſence of clay; and lime is indicated by its aſſuming a whitiſh colour, either ſtriated, or diſſeminated, approaching towards the ſurface of the ſtone.

The laſt method mentioned, namely, that of depriving a given portion of ore of its iron, is the moſt conſonant to truth and to the ideas of the manufacturer. Acids may be uſed as a check upon the aſſay by fuſion; but this intricate, or rather this ſlow proceſs is chiefly reſorted to by chemiſts, and ſeldom goes beyond the bounds of the laboratory. In aſſaying by fuſion, not only the quantity of iron may with preciſion be aſcertained, but alſo the quality of crude-iron likely to be produced from the ore, with the local proportions of fuel in the large way. The earths formerly united with the iron, now become fuſed with thoſe added for ſolvents. Theſe float upon the ſurface of the extracted metal, and, when cold, may afford information, from their colour and tranſparency, concerning the regulation of future proportions upon a more extended ſcale. This ſubject I ſhall more minutely illuſtrate in a ſubſequent paper on the aſſaying of iron-ores by fuſion.

The burning or torrefying of iron-ſtones, known in the large way by the rather improper term of *calcination*, conſiſts in expoſing the ſtone to a certain degree of heat in contact with air, in order to diſpel thoſe ſubſtances which it contains,

contains, capable of aſſuming the aëriform ſtate by the combination of caloric. This operation ought to be performed in a progreſſive heat, always ſhort of fuſion. The water is then ſlowly evaporated without being decompoſed; the caloric unites to the carbonic acid, which ſoon aſſumes the gaſeous ſtate; and laſtly, the ſulphur, if any, ſublimates.

This proceſs is eſſentially neceſſary to be performed before the iron-ſtone is introduced into the blaſt-furnace. Were raw iron-ſtone, or ore, precipitated in the violent heat of the ſmelting-furnace, the water and acid would inſtantly be decompoſed; the oxygen would partly unite to the iron in addition to the fixed quantity peculiar to each ore, and part of it would oxygenate the ſulphur, either of the ore, or of the pit-coal, a portion of which is always preſent in the furnace. The whole maſs would then be precipitated in fuſion, and a dark porous lava obtained, containing iron more difficult to be revived than ever, owing to the great quantity of oxygen combined with it. In caſes of this kind, the diſengaged hydrogen manifeſts its eſcape, by changing the colour of the flame from a mellow white to a pale ſickly blue.

It muſt from all this appear obvious, that, when torrefaction has been properly conducted, a very conſiderable part by weight of the whole will be diſſipated: the abſence of theſe volatile ſubſtances always leaves the iron-ſtones more or leſs magnetic. The loſs of weight, however, is very different in the various claſſes of iron-ſtones, even when they are all expoſed for the ſame length of time to a degree of heat capable of expelling thoſe mixtures, which, under ſuch circumſtances, aſſume the gaſeous ſtate.

1. Calcareous iron-ſtone, when properly expoſed to torrefaction, loſes more of its weight than either of the other two claſſes. Where the lime is abundant, I have found this iron ſtone loſe 38 per cent. but more commonly 35 and 36 per cent. of water, carbonic acid, and ſulphur.

2. Ar-

2. Argillaceous iron-ſtones, expoſed to a ſimilar degree of heat, and treated in the ſame manner, commonly loſe in weight from 32 to 35 per cent.

3. Siliceous iron-ſtones always give out leſs weight when expoſed to torrefaction under ſimilar circumſtances with other ſtones. In common they loſe from 27 to 30 per cent. I have, though rarely, found them to give out 25 per cent. only.

The extreme loſs of weight in each claſs muſt be conſidered as the utmoſt point to which torrefaction can with ſafety be urged, without expoſing the iron-ſtone to an accumulation of weight by the combination of oxygen.

From the variouſly compounded natures of iron-ſtones ariſe the various calculations of the loſs which they are ſaid to ſuſtain in burning, at different iron-works. Fields of iron-ſtone are commonly impreſſed with a general diſtinguiſhing characteriſtic feature: ſome are of the calcareous genus; ſome of the argillaceous; and others again have a more intimate alliance with ſilex than the former two. Hence we find, at thoſe works where the chief ſupply is drawn from the argillaceous iron-ſtones, that the loſs in torrefaction on the great ſcale is computed from 30 to 33 per cent. Where calcareous iron-ſtones form the chief ſupply, the loſs is eſtimated at from 35 to 37½ per cent. Few or no iron-works are obliged to have recourſe to iron-ſtones abounding with ſand for their chief conſumption: a general eſtimation of the loſs ſuſtained by this ſtone in the large way is therefore difficult to be made, though, I have heard, that at ſome works 25 per cent. was all that was allowed to be expelled during burning. Nature has been extremely kind in the formation of our ſecondary ores of iron; as the bulk of them, that contain iron ſufficient to entitle them to be ſmelted, are combined with ſuperior proportions of clay and lime.

As the burning or torrefying of iron-ſtones is of great importance

portance to the manufacturer, and as it may be in ſome reſpects gratifying to the man of ſcience, I ſhall particularly enter into the various phenomena attending the operation; dividing torrefaction into two claſſes: that which deprives iron-ſtones of certain ſubſtances capable of becoming aëriform by the combination of caloric in contact with atmoſpheric air; and that which deprives ores of their oxygen—, hence called de-oxygenation—by heating them in contact with charcoal, in cloſed veſſels, or in cavities impervious to the external air.

1. The conſequences of heating iron-ſtone expoſed to air is a loſs of water, ſulphur, and carbonic acid*. A ſmall portion of oxygen may at times be unfixed, when the fuel may chance to come into contact with the heated iron-ſtone under a partial excluſion from air. But the aſſociation of circumſtances neceſſary to effect this can ſo ſeldom be the effect of chance, that it is never to be looked for with certainty. When the operation is properly performed, the laſt particle of acid and water may be expelled. But this point is difficult to be aſcertained with any degree of exactitude: for, in proportion as theſe gaſeous ſubſtances are carried off, the metal becomes more and more revived, of courſe more and more liable to attract, and fix oxygen by the decompo-

* I have ſeen ſome iron-ſtones in torrefying depoſit a beautiful oxyde upon their ſurface, of a lake colour, and light as down. The ſame ſubſtance, I have obſerved, effloreſced upon the ſurface of the fracture of highly oxygenated crude iron, which had been broken immediately after the metal had loſt its fluidity. From this coincidence of effect, I am inclined to ſuppoſe, that the oxyde depoſited on the iron-ſtone in burning is the conſequence of the decompoſition of the ſulphuric acid; a portion of which had been mineraliſed with the ſtone, holding iron in ſolution: and that in the latter it was occaſioned by a ſuperabundance of oxygen in the blaſt-furnace, probably from the introduction of raw iron-ſtone, which had eſcaped the effects of the fire: that the ſulphur, as formerly ſtated, had become oxygenated, diſſolving a portion of the metal; which was again depoſited in the ſtate of a calcined ſulphat, when the acid was ſuffered to eſcape, by being freely expoſed at a high degree of heat to open air.

ſition

ſition of the ignited gas; and, as the laſt portions of the acid and water are diſtilling, the ſtone is apt to gain weight by the calcination (oxygenation) of its iron. This will poſitively be the caſe when the heat is carried beyond the neceſſary degree, and is indicated by the iron-ſtone ſwelling in bulk, becoming ſpecifically lighter and porous on the ſurface, but gaining weight in a great degree internally. As oxygenation goes on, the magnetic virtue decreaſes, until at laſt it becomes entirely annihilated.

The firſt ſtage in torrefaction is indicated by the firſt general change of colour in the iron-ſtone. This is commonly a faded blood colour, more or leſs dark according to the quantity of lime preſent.

I have repeatedly made uſe of all the various iron-ſtones, in the ſtate of a fine powder, in order to aſcertain what was the weight loſt by each claſs in its tranſition from its native hue to the firſt ſtage of an aſſumed colour. And I am enabled to ſtate the following as an average of the reſults obtained on this head: Calcareous iron-ſtones give out 6 parts in 100 of the raw mineral; argillaceous iron-ſtones, 5; and ſiliceous iron-ſtones, $4\frac{1}{2}$.

If the pulveriſed iron-ſtone is thrown into a veſſel red hot, this loſs will be effected in two minutes. The change of colour is immediately effected on thoſe parts in contact with the heated iron. The whole is brought into contact with it; and when thrown out, the magnet will be found to have acquired a perceptible influence over it. When the powder is firſt thrown in, a ſlight decrepitating noiſe is heard for a few ſeconds. This operation may alſo ſerve to ſhew the preſence of ſulphur, or of its acid. When in the former ſtate it inſtantly takes fire, and burns with a dark lambent flame. When the acid is preſent, it is eaſily known by the ſuffocating fumes diſengaged by the action of heat.

The application of heat beyond the firſt ſtage of colour, cauſes the iron-ſtone to paſs through a variety of ſhades.

These,

Theſe, as in metallic ſubſtances, are the effects of the preſence of air at certain degrees of heat *. As the progreſſive diſſipation of the volatile mixtures takes effect, the colour deepens; and, according to the nature of the iron-ſtone, becomes fixed, of a brown, dark brown, or deep claret colour. Theſe indicate the almoſt entire expulſion of the water, acid, &c. In this ſtate all iron-ſtones are poſſeſſed of magnetic attraction, and exhibit the various phenomena already deſcribed, as being peculiar to their reſpective natures.

The methods commonly in uſe for torrefying iron-ſtone, in the large way, are of two different kinds: that of burning in kilns or conical furnaces; and that of expoſing iron-ſtone in open air, ſtratified with coals, to combuſtion. The former is uſed in ſome places in Wales; the latter is almoſt univerſally adopted in England, and totally ſo in Scotland.

In the operation with furnaces, they become filled entirely with iron-ſtone, except a ſtratum of coals in the bottom, which is afterwards inflamed. The combuſtion is then carried on by means of a current of air paſſing through the furnace, and forcing the heat along with it. When the iron-ſtone is deemed ſufficiently burnt, the regiſter is ſhut up; and the combuſtion, no longer maintained by means of external air, ſoon dies away, and leaves the furnace to cool.

The moſt common method, however, of burning iron-ſtones, conſiſts in levelling a piece of ground, and covering it with a layer of ſmall pit-coals. This is of various thickneſſes, 4, 6 or 8 inches, according to the height the pile is to be built, and the nature of the iron-ſtone. Upon this ſtratum of coals the pieces of iron-ſtone are imbedded, as near to the ſame ſize as poſſible, in order that all may be equally acted upon. Theſe are reared to various heights,

* From ſmooth-ſurfaced iron-ſtones and ores, when expoſed to heat partially ſheltered by charcoal duſt from the action of air, I have obtained all the ſhades of colour peculiar to poliſhed iron and ſteel; but with leſs of the metallic luſtre, owing to the ſurface being more porous.

18, 20 to 24 inches, the determination of its height depending upon circumſtances. The ſurface is a ſecond time levelled, by introducing ſmall pieces of iron-ſtone betwixt the interſtices occaſioned by the angles of the larger. This again receives a covering of ſmall coals, ſeldom exceeding 2 inches in thickneſs. Upon this is reared the ſubſequent building, always gradually narrowing itſelf till it has aſſumed the ſhape of a ſtout wedge, with its baſe reſting upon the ground. After this is effected, the whole of the external ſurface receives a complete covering of the ſmalleſt ſort of coals. The pile is kindled by applying burning coals to the ground ſtratum. This creeps ſlowly along; heats the ſtone upwards; kindles the ſecond layer of ſmall coals, and ultimately inflames the whole maſs from top to bottom.

When the coals are conſumed, the pile gradually cools, and in 8 or 10 days may be wheeled away to the furnace.

The quantity of iron-ſtone burnt at one time is various at different and even at the ſame places; ſome kinds require to be burnt in ſmaller heaps, owing to their nature and fuſibility. At ſome works the fires extend from 50 to 60 yards; and it is not uncommon to ſee ſkilful workmen, at one end, adding freſh materials to the burning pile; while others, at the oppoſite end, are employed wheeling away that which the fire has left ſufficiently burned for the purpoſe of the furnace. Fires that extend from 30 to 60 feet in length are more common; from 10 to 16 feet wide, and about 5 feet high.

At moſt iron-works a local opinion exiſts, to what degree of heat iron-ſtone ought to be expoſed before it is properly fit for the blaſt-furnace. All, however, agree that burning is neceſſary; though few give an accurate reaſon why. The only one I have heard adduced is, that iron-ſtone is *calcined* in order to burn out the ſulphur and other *heterogeneous* mixtures. Hence ariſe a diverſity of opinions, chiefly founded upon individual notions of the fixity or volatility of ſulphur,

ſulphur. Some contend that ſulphur is eaſily diſplaced, and that therefore the iron-ſtone ſhould be moderately *calcined*; leſt the ſulphur from the coal uſed in burning it ſhould enter, and again hurt the quality of the iron. On the other hand, it is ſaid that ſulphur is of difficult expulſion from the centre of the ſtone, as it is never ſeen going off till a bright red heat forcibly expels it; and therefore it is highly requiſite the iron-ſtone ſhould be long and violently expoſed till the laſt portion is got rid of. To effect this, therefore, the heat, ſay they, ought to be urged till ſuch time as the ſtone has indicated ſigns of fuſion, or has partially ſuffered thereby. In order to give ſtrength to this opinion, thoſe who adopt it add, that, by ſuch ſevere *calcination*, the volume of ſtone is reduced, becomes heavier, and that it will conſequently occupy leſs room in the blaſt-furnace; of courſe it is imagined that, bulk for bulk, the iron-ſtone becomes richer in iron than when in a raw ſtate.

Thoſe who are acquainted with the oxydation of metals, and the conſequent increaſe of weight, will at once diſcover the ſource of this error, and readily conceive, that, after the metal in the iron-ſtone has become partially diſengaged by the expulſion of water, carbon acid, ſulphur, &c. forming frequently a third part of the whole weight, it will become an object of attack to the oxygen of the atmoſpheric air; the combination of which with the iron alone adds to the actual increaſe of weight, and not the tranſpoſition of the particles of metal from one piece of iron-ſtone to another. It muſt alſo be obvious that, where ſuch fallacious prejudices have taken root, the conſequences muſt frequently be fatal to the intereſts of the manufacturer; as ſuch iron-ſtones, literally calcined, muſt require an additional portion of fuel to furniſh carbon to carry off the ſuperadded oxygen.

It is ſomewhat remarkable that the phenomena attending the oxydation of iron ſhould be entirely unknown at iron manufactories. Such a proceſs is never dreamt of, and even the declaimers againſt ſevere torrefaction only account for

for the increaſe of weight, by aſſerting that the earthy parts are burnt out and nearly conſumed; and that the metallic parts only remain, deſtroyed however in their nature and *reduced to a cinder.*

We are not to wonder, therefore, at the uncertain reſults which the untutored manufacturer obtains; until ſuch time as a long courſe of experience has taught him, that, by combining certain cauſes, good or bad effects are the conſequence. Even at laſt he ſtill reſts upon an unſtable baſis: deſtitute of the correct operation of principle, and incapable of preventing an evil from a total ignorance of its real ſource of action, he can only in the end avoid it after a multiplicity of movements, wherein he finds his practical knowledge increaſed at the expence of a conſiderable ſacrifice of property.

How much more enlightened would be the mind of the manufacturer, were he to attend minutely to the phenomena developed in all the ſtages of his proceſs, and ſatisfy himſelf as to the radical principles of action in each individual ſtage! In doing this, chemical minuteneſs, the terror and butt of the unphiloſophiſed mind, is not abſolutely indiſpenſible; and yet every thing may be aſcertained neceſſary to be known for the production of certain determinate qualities of crude iron.

He would then eaſily comprehend that all iron-ſtones contain leſs or more water of cryſtalliſation, and that, being combined with a certain proportion of lime neutraliſed with carbonic acid, it is neceſſary that they be expoſed to a heat ſufficient to expel the firſt and laſt of theſe as well as ſulphur. The reaſon has already been given, and the conſequence ſhall be once more ſtated. The evil effects produced by introducing raw iron-ſtones into the blaſt-furnace, are leſs owing to the ſmall portion of ſulphur contained in moſt of them, eſpecially in balls, (the vapours of which ariſe even from the ſofteſt crude iron when fluid,) than to the decompoſition of water and acids, each of which gives up

a pro-a proportion of oxygen to the metal, chiefly before ſeparation is effected.

Does it not then unqueſtionably follow, that if the quantity of charcoal in the furnace formerly was ſufficient to take up the oxygen exiſting in the ore, and to afford carbonated crude-iron, that if a further quantity of this principle is added, by whatever means, part of the charcoal which formerly went to carbonate the iron now combines with the ſuperadded oxygen to form carbonic acid; of courſe the metal will be deprived of its carbon, become white in the fracture, and may then juſtly be denominated oxygenated crude-iron. The ſame application to principle would alſo inform the merely practical man, that when iron-ſtone is completely deprived of thoſe ſubſtances which aſſume the gaſeous ſtate by the combination of caloric at a moderate temperature, it is then ſufficiently prepared for the furnace. This is always indicated by the colour which the ſtone aſſumes varying from a brown to a dark claret. Blues always ſucceed this ſhade; and the ſmalleſt appearance of blue, however light, is a certain ſign that the external air has made an impreſſion upon the particles of metal, by ſuperoxygenating them. Inſtead therefore of expelling a further quantity of *heterogeneous* matter, a principle is added the moſt noxious and deſtructive to the exiſtence of iron in a metallic form.

The phenomenon of iron-ſtone becoming heavier in the fire, would no longer be explained by aſſuming vague aſſertions incompatible with and inadmiſſible to common ſenſe. Upon finding two pieces of iron-ſtone in the ſame fire, which have to appearance been affected in a widely different manner by the heat; the one heavy, of a black blueiſh colour; the other light and porous: the practical man would now no longer ſay that the metal from the porous piece had eſcaped by theſe pores, and entered into the ponderous one; and that the accumulation of weight in the latter was entirely owing to it abſtracting the metal

 from

from the former. Widely different indeed would be the concluſion. He now would have learned that metals are combuſtible bodies; that under certain circumſtances iron is one of the moſt inflammable in the group; that, during its combuſtion, it decompoſes the air that maintains the combuſtion, and fixes one of its elements in ſpite of the powerful affinity exerted upon it by the caloric; and that by this proceſs alone it increaſes its volume and weight. The porous maſs of iron-ſtone would now be deſcribed as having had its iron completely ſaturated with oxygen at a very high temperature; that an imperfect ſtate of fuſion had been the conſequence; and that a combination of theſe circumſtances, acting for a conſiderable length of time, had volatiliſed and carried off a very conſiderable portion of the metal.

On the ſame principle would be explained the increaſe of weight in the more ponderous piece; it would then readily be conceived, that the ſame aſſociation of circumſtances had not been preſent; but that the iron had gained in weight by the addition of oxygen at a temperature ſhort of fuſing and volatiliſing the oxyd.

What I have further to ſtate on this ſubject ſhall be forwarded for the next Number of the Philoſophical Magazine. In the mean time I ſhall ſubjoin a few remarks which may be conſidered in the light of a

Poſtſcript to the Paper on the Principles of Iron and Steel.

In that paper (Phil. Mag. Vol. II. p. 165) I ſtated that the carbon which exiſts in ſteel is in an elaſtic or aëriform ſtate. In a long ſeries of experiments which I made on the diſſolution of crude-iron and ſteel in various acids and in water, I always obtained carbon from the former in a crude concrete form; but the carbon in ſteel always eluded my ſearch, and never appeared till ſome days afterwards, in the manner of a greaſy pellicle, thin and tranſparent upon the

the surface of the fluids. This circumstance confirmed what had long been evident to me, from a knowledge of the principles and the mode of conveying them in manufacturing both these states of iron, that the carbon in crude iron and that in steel existed in a widely different mode of union. And as in the latter it existed not in a crude state, I was led to conclude that an aëriform chemical union was effected, during the process of cementing the steel, by the agency of the caloric on the charcoal, which stratifies the bars during the operation.

In my correspondence, however, with the Editor of the Philosophical Magazine, he threw out some hints that a different kind of chemical union might be effected by the same agency, and that in steel the carbon might exist in a concrete state, though not crude – neutral, though not aëriform. This combination, which I had overlooked, (*humanum est errare!*) appeared so highly probable that I resumed my experiments; and I am happy in now stating that this idea was just, as I have since obtained from steel carbon in the state of an impalpable powder, by the following simple operation.

I introduced into a glass vessel a plate of polished steel, and poured upon it as much clear rain water as covered it three inches. In this state it remained for 50 days, during which time I carefully observed the agency of the water upon the metal. Twenty-four hours after introduction, minute flakes were observed floating lightly in the water; they increased on the second and third days, and fell gradually towards the bottom. As these accumulated, the surface of the water became covered with the same carbonaceous pellicle mentioned above*, exactly resembling the coloured film which is frequently found floating upon the surface of springs where iron is precipitated from the carbonic acid.

* A plate of pure malleable iron underwent a similar immersion in a separate vessel, but exhibited no disengagement of carbon in this state.

During the immerſion of the ſteel, a double affinity was exerted; part of the oxygen of the decompoſed water united to the carbon to form carbonic acid: this union was at any time highly facilitated by raiſing the temperature of the water. The precipitate and oxyd upon the ſurface of the plate then became covered with tranſparent bubbles, which remained if the temperature was decreaſed; but on the contrary roſe to the top and eſcaped, if the heat was augmented. The other affinity excited was that of the oxygen upon the iron; which it ſlowly oxydated, covering the ſurface at firſt with a ſlight yellow membrane of the thickneſs of gold leaf. This daily increaſed, and at the end of fifty days had acquired firmneſs and conſiſtency. After carefully drying the plate, I began to ſeparate the oxyd from the ſurface. This eaſily parted in ſcales, and under it I found the ſurface of the plate entirely covered with fine carbon, without greaſe or the ſmalleſt aſperity. When ſtrewed in the fire, it ſparkled and exhibited the ſame characters as charcoal.

This experiment proves clearly that carbon exiſts in ſteel in a concrete ſtate, though not crude—in chemical union, however, and not as a mere mixture as in crude iron.

I cannot conclude this note without ——————*, and expreſſing a hope that the confirmation of this fact may lead to a ſolution of many of the phenomena attending the manufacture of iron.

* The author here pays us a compliment to which we have no claim, and having already inſerted enough of what reſpects ourſelves to ſhew that we would not willingly diſobey his commands, we hope he will excuſe this ſmall chaſm. EDIT.

XVII. *A remarkable Caſe of internal Pain in the Heel, and an incipient Mortification, cured by the Inhalation of Vital Air: being the Third Communication from* Dr. THORNTON, *Phyſician to the General Diſpenſary, and Lecturer on Medical Botany at Guy's Hoſpital, relative to Pneumatic Medicine.*

MRS. FRITH, æt. 45, wife of the Rev. William Frith, rector of Kentiſh Town, for nearly four years experienced the moſt violent pain in the neighbourhood of the heel, which ſhe could compare to nothing but the burning of a cauſtic. Various outward applications had been made, and medicines taken internally, without any alleviation. When Mr. Cruikſhank, lecturer on anatomy in the ſchool of Dr. Hunter, called me into conſultation, there was extended over the heel a wound about the ſize of a crown, very dark, the edges livid; and the fœtor from it was ſo intolerable that, when her maid had occaſion to remove the dreſſings, ſhe had always volatiles applied to the noſtrils to prevent her from fainting. The countenance ſhewed a livid paleneſs, the pulſe was quick and tremulous, and the ſlighteſt exertion produced faintings. The bark, opium, and wine, were continued. This lady inhaled alſo ſix quarts vital air mixed with twelve of atmoſpheric, and in a few days, as this reſpectable family can alſo teſtify, the livid hue of the wound diſappeared, it had a more healthy appearance, and the diſcharge was ſo greatly improved, and fœtor gone, that when the ſmelling-bottle was preſented to the ſervant, ſhe ſaid that there was not the leaſt occaſion for it. In a fortnight the ſore was completely healed, the appetite reſtored, and countenance ſo greatly improved that every friend marked the ſudden alteration; the violence of the internal pain leſſened by degrees, and the ſuperoxygenated air being continued for a few weeks longer, it altogether ſubſided; and this lady for theſe laſt ſix months has enjoyed

 uninterrupted

uninterrupted health, and is able, at pleaſure, to walk up Highgate-hill.

As many perſons might wiſh to ſee the lady's journal in her own words, I here ſubjoin it, with a few obſervations.

"September 13. 1798. Firſt inhaled the vital air. Felt acute ſpaſms in the cheſt, and fainted."

Obſervation. Artificial inhalation is accompanied with increaſed action of the intercoſtal muſcles, and gives frequently afterwards a ſenſation of muſcular pain, which ſpeedily goes off, and after a few trials does not appear again. The ſecond effect we always ſee in thoſe very weak, and hence the expreſſion of "*being overpowered by the air.*" Patients labouring under ſcurvy, if ſuddenly expoſed to a clear air, are killed inſtantaneouſly.

"September 15. Felt a moſt pleaſant glow after the inhalation of the vital air. Spirits alſo much increaſed, feeling as if a great weight, or oppreſſion, was removed.

"September 16. The hardneſs about the heel gone, as alſo the fœtor. Has leſs diſcharge. The wound looks redder. The glow after the inhalation of the vital air laſts for about a quarter of an hour.

"September 18. The glow, and ſpirits, after the laſt inhalation, laſted four hours. Feel wonderfully light, and pleaſant.

"September 20. Aſked by my apothecary, 'Whether I did not feel, from the inhalation of the vital air, an *uncomfortable heat?*' My anſwer was, that it produced the moſt pleaſant glow imaginable, not at all reſembling *heat.*"

Obſervation. Putting the thermometer under the tongue, the ſenſible heat was not increaſed. This effect may perhaps be accounted for from the increaſed ſenſibility of the nerves; or, does the inſenſible perſpiration raiſed by the capillaries of the ſkin being filled by the greater energy of the heart, account for this phenomenon better? I have almoſt invariably found the inſide of the palm of the hand, after,

and

and during the inhalation, break out in a pleafant moifture, which are parts fomewhat remote from the heart.

" October 4. The pain in the heel infinitely more lively. The pain is a *new pain*; but, thanks be to God! it remits for three or four hours every day."

Thefe are the chief particulars: the nature of your Magazine may not admit of a further detail, nor does the nature of the cafe feem to require it.

General Obfervation. The change of colour in the wound, fo immediately after the inhalation of the vital air, feems to indicate a remarkable change wrought in the blood. It is not, however, the temporary increafe of oxygen only in the fyftem, that this partial inhalation produces; for it renders the blood alfo more attractive of this principle. Hence the continuance for fome time, even in London, among people of fafhion, of the good looks acquired in the country; hence the pallid countenance of the man lately recovered from fuffocation, or drowning; and hence alfo the return of the breath in patients under this treatment being more and more noxious, from a greater abforption of oxygen. The deterioration of the air infpired, has ever indicated the attractive power of the blood. Hence alfo it is that fubftances abounding in hydrogen are called cordials, from their fympathetic action on the heart, through the medium of the blood: but in the fuperoxygenated air we have a more direct action on the heart, without exhaufting the irritable principle, and occafioning indirect debility; and I truft I fhall be able to make it evident to the unprejudiced mind, that this is a great defideratum in furgery and medicine, more efpecially where difeafes are remote from the heart; or elfe, why do we fo frequently hear of *fore legs*, but never of *fore arms?* But, however the *modus operandi* of thefe new powers may be, the obfervance of *facts* is of greater importance; and I here beg leave publicly to thank thofe ingenious medical gentlemen who have honoured me with their correfpondence on this fubject, the refult of which will be laid before the philofophic world.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

ROYAL SOCIETY OF LONDON.

AT the meeting of this learned body on the 21ſt of February, a work of great utility to aſtronomers was read—Dr. Herſchel's 4th catalogue of the fixed ſtars, with their comparative brightneſs.

On the 28th of February a meteorological paper by Mr. Hutchinſon was read; and a curious paper on the ſubmerged foreſts on the coaſt of Lincolnſhire, endeavouring to aſcertain the epoch of the phenomenon, and containing geological obſervations on the different ſtates in which trees are found in the earth, by Mr. Joſeph Serra de Correa.

The meetings of March 7th and 14th were occupied in reading a curious paper on hermaphrodites; which contains alſo an account of ſome ſingular experiments on human generation, ſimilar to thoſe made by Spalanzani on the canine ſpecies.

INSTITUTION

For diffuſing the Knowledge, and facilitating the general Introduction of uſeful Mechanical Inventions and Improvements; and for teaching, by Courſes of Philoſophical Lectures and Experiments, the Application of Science to the common Purpoſes of Life.

OUR readers will be happy to learn that a new Inſtitution under the above title, which promiſes to be of great public utility, has been ſet on foot in this capital, and is expected ſhortly to be eſtabliſhed by Royal charter. The Right Hon. Sir Joſeph Banks, who has ſo long, and with ſo much honour

honour to himſelf, preſided over the Royal Society, and whoſe ardour in purſuing whatever objects may tend to promote the intereſts of ſcience can only be equalled by his liberality in devoting to their advancement a large portion of a princely income, has given every aid, by his own perſonal exertions and his extenſive influence, to give effect to the plan of this Inſtitution, which was projected by Count Rumford, the ſtrenuous advocate for the application of ſcience to the common purpoſes of life.

We ſhall give ſuch a ſketch of the plan as our limits will allow, extracted from Count Rumford's original propoſals for forming the Inſtitution, which may be had (Price 6d.) of Meſſrs. Cadell and Davies.

The two great objects of the Inſtitution are, the ſpeedy and general diffuſion of the knowledge of all new and uſeful improvements, in whatever quarter of the world they may originate; and, teaching the application of ſcientific diſcoveries to the improvement of arts and manufactures in this country, and to the increaſe of domeſtic comfort and convenience.

Rooms will be prepared for the reception and public exhibition of all new and mechanical inventions and improvements worthy of notice; eſpecially of all ſuch as tend to increaſe the conveniences and comforts of life, to promote domeſtic economy, to improve taſte, or to promote uſeful induſtry.

Perfect models, of the full ſize, will be exhibited in this public repoſitory, of all ſuch new mechanical inventions and improvements as are applicable to the common purpoſes of life. Under this head is included: Cottage fire-places, and kitchen utenſils for cottagers; a complete kitchen for a farm-houſe, with all the neceſſary utenſils; a complete kitchen, with kitchen utenſils, for the family of a gentleman of fortune; a complete laundry for a gentleman's family, or for a public hoſpital; ſeveral of the moſt approved ſtoves for heating rooms and paſſages.

The

The machinery exhibited will, as far as poſſible, be ſhewn in action, or in actual uſe.

Open chimney fire-places, on the moſt approved principles, will be fitted up as models in the different rooms; and fires will be kept conſtantly burning in them during the cold ſeaſon. Ornamental as well as economical grates, for open chimney fire-places, will alſo be exhibited; ornamental ſtoves, in the form of elegant chimney-pieces, for halls, drawing-rooms, eating-rooms, &c.

Working models of the ſteam engine; of brewer's boilers; of diſtiller's coppers with improved condenſers; of large boilers for the kitchens of hoſpitals; and of ſhip's coppers; all with improved fire-places.

Models of ventilators; of hot-houſes; of lime kilns; of boilers, ſteam-boilers, &c. for preparing food for cattle that are ſtall-fed; of cottages.

Various ſpinning-wheels and looms, with ſuch other machinery as may be uſeful in giving the poor employment at home.

Models of all ſuch new-invented machines and implements as bid fair to be of uſe in huſbandry; of bridges, on various conſtructions; and of all ſuch other machines and uſeful inſtruments as the managers ſhall deem worthy of the public notice:—each article exhibited to be accompanied with a deſcription of it properly illuſtrated by correct drawings, the name of the maker, the place of his abode, and the price.

A lecture-room will be fitted up, and a complete laboratory and philoſophical apparatus, with the neceſſary inſtruments, be provided for making chemical and other philoſophical experiments.

Men of the firſt eminence in ſcience will be engaged as lecturers; and no ſubjects be permitted to be diſcuſſed but ſuch as are ſtrictly ſcientifical, and immediately connected with that particular branch of ſcience publicly announced as the ſubject of the lecture.

Among

Among the branches of science that will occasionally be made the subjects of these public lectures, are the following:

Of heat, and its application to the various purposes of life; of the combustion of inflammable bodies, and the relative quantities of heat producible by the different substances used as fuel; of the management of fire and the economy of fuel; of the principles of the warmth of clothing; of the effects of heat and of cold, and of hot and of cold winds, on the human body, in sickness and in health; of the effects of breathing vitiated and confined air; of means to render dwelling-houses comfortable and salubrious; of the methods of procuring and preserving ice in summer, and of the best principles for constructing ice-houses; of the means of preserving food in different seasons and climates; of the means of cooling liquors without the assistance of ice; of vegetation, and of the specific nature of those effects that are produced by manures; and of the art of composing manures, and adapting them to the different kinds of soil; of the nature of those changes that are produced on substances used as food in the various processes of cookery; of the nature of those changes which take place in the digestion of food; of the chemical principles of the process of tanning leather, and of the objects that must particularly be had in view in attempts to improve that most useful art; of the chemical principles of the art of making soap; of the art of bleaching; of the art of dyeing; and, in general, of all the mechanical arts, as they apply to the various branches of manufacture.

The money necessary for defraying the expence of forming this Institution, and also for the future expence of keeping it up, is to be raised: 1st, By the sums subscribed by the original founders and sole proprietors of the Institution, at fifty guineas each person, to be but once paid. 2dly, By the sums contributed by those who shall subscribe for life, at ten guineas each person, to be but once paid. 3dly, By the sums contributed by the annual subscribers, at two guineas per annum for each perſon. 4thly, By the particular donations and legacies. And laſtly, by ſums received at the door from ſtrangers who viſit the Repoſitory, or obtain leave to frequent the Lectures.

Each original ſubſcriber or proprietor, beſides other privileges, will be an hereditary governor of the Inſtitution; have a perpetual transferable ſhare in all the property belonging to it; a voice in the election of the managers of the Inſtitution, as alſo in the election of the committee of viſitors; two transferable tickets of perpetual admiſſion into the eſtabliſhment, and into every part of it; two transferable tickets of admiſſion to all the public philoſophical lectures and experiments; and may recommend perſons for admittance to the philoſophical lectures and experiments.

Each ſubſcriber for life will receive one ticket for life, but not transferable, of free admiſſion into the Inſtitution, and into every part of it; together with one other ticket for life, but not transferable, of free admiſſion to all public philoſophical lectures and experiments.

Each annual ſubſcriber's tickets will be for one year, but not transferable.

Subſcribers for life, and annual ſubſcribers, as well as the proprietors of the Inſtitution, will be entitled to have copies or drawings (made at their own expence) of any of the models in the repoſitory, and this even when ſuch copies are deſigned for the uſe of their friends; and workſhops will be prepared, and workmen provided under the direction of the managers for executing ſuch work properly, and at reaſonable prices.

Perſons employed in executing work after any of the models, will, on the recommendation of any ſubſcriber, be allowed acceſs to ſuch model as often as ſhall be neceſſary: and ſuch of them as ſhall be willing to furniſh to buyers any article exhibited in the repoſitory, will be allowed to place a ſpecimen in the repoſitory, with his name and place of abode

abode attached to it, and the price at which he can furnish it; such specimen having been examined and approved by the managers.

The design or object of the Institution is not to give rewards to the authors of ingenious inventions, but to diffuse the knowledge of such improvements as bid fair to be of general use, and to facilitate the general introduction of them; and to excite and assist the ingenious and the enterprising by the diffusion of science, and by awakening a spirit of inquiry.

In order that the proprietors of the Institution, and the subscribers, may have the earliest notice of all new discoveries and useful improvements that shall be made from time to time, not only in this country, but also in all the different parts of the world, the managers will employ the proper means for obtaining, as early as possible, from every part of the British empire, and from all foreign countries, authentic accounts of all such new and interesting discoveries in the various branches of science, and in arts and manufactures, and also of all such new and useful mechanical improvements as shall be made; and a room will be set apart in the Institution, where all such information will be lodged, and where it will be kept for the sole and exclusive use and inspection of the proprietors and subscribers, and where no stranger will ever be admitted.

Several resolutions adopted at a general meeting of the proprietors, held at the house of the Right Honourable Sir Joseph Banks, Bart. K. B. in Soho Square, on the 7th day of March 1799, having been published in the daily papers, need not be here repeated.

The following list of the proprietors, and original subscribers of 50 guineas each, deserves, however, to be recorded in the present account of the Institution:

Sir Robert Ainslie, Bart.	Scrope Bernard, Esq. M.P.
J. J. Angerstein, Esq.	The Earl of Besborough.
Right Hon. Sir Joseph Banks, K. B.	Rowland Burdon, Esq. M. P.
Thomas Bernard, Esq.	James Burton, Esq.

Timothy

Timothy Brent, Esq.
Henry Cavendish, Esq.
Rich. Clark, Esq. Chamb. of Lond.
Sir John Colpoys, K. B.
John Craufurd, Esq.
The Duke of Devonshire, K. G.
Andrew Douglas, Esq.
The Lord Bishop of Durham.
The Earl of Egremont.
George Ellis, Esq. M. P.
Joseph Grote, Esq.
Sir Robert Bateson Harvey, Bart.
Sir John Cox Hippesley, Bart.
Henry Hoare, Esq.
Lord Hobart.
Lord Holland.
Henry Hope, Esq.
Thomas Hope, Esq.
Lord Keith, K. B.
William Lushington, Esq. M. P.
Sir John Macpherson, Bart. M. P.
William Manning, Esq. M. P.
The Earl of Mansfield.
The Earl of Morton, K. T.
Lord Offulston.
Thomas Palmer, Esq.
The Lord Viscount Palmerston, M. P.
Edward Parry, Esq.
Right Hon. Thomas Pelham, M. P.
John Penn, Esq.
William Morton Pitt, Esq. M. P.
Sir James Pulteney, Bart. M. P.
Sir John Buchanan Riddell, Bart.
Count Rumford.
Sir John Sinclair, Bart. M. P.
Lord Somerville.
John Spalding, Esq. M. P.
The Earl Spencer, K. G.
Sir George Staunton, Bart.
John Sullivan, Esq.
Richard Joseph Sulivan, Esq.
Lord Teignmouth.
John Thomson, Esq.
Samuel Thornton, Esq. M. P.
Henry Thornton, Esq. M. P.
George Vansittart, Esq. M. P.
William Wilberforce, Esq. M. P.
The Earl of Winchelsea.
Hon. James Stuart Wortley, M. P.
Sir William Young, Bart. M. P.

The following proprietors have been elected as the first managers of the Institution.

For three years: The Earl Spencer; Count Rumford; Richard Clarke, Esq.——For two years: The Earl of Egremont; Right Hon. Sir Joseph Banks; Rich. Joseph Sulivan, Esq.——For one year: The Earl of Morton; the Right Hon. Thomas Pelham; Thomas Bernard, Esq.

At a meeting of the Managers held on the 9th of March, it was resolved, among other things, That the Earl of Morton, the Earl Spencer, Sir Joseph Banks, and Mr. Pelham, should be requested to lay the Proposals for forming the Institution before his Majesty and the Royal Family, and before his Majesty's Ministers and the Great Officers of State;—and, That the Proposals for forming the Institution be laid before the Members of both Houses of Parliament, and also before the Members of his Majesty's Most Honourable Privy Council, and the Twelve Judges.

COW-POX.

WE have already given an account of Drs. Jenner and Pearſon's publications on the cow-pox, which tended to eſtabliſh the important fact, that thoſe who have had that diſeaſe, which never proves fatal, and which may always be ſo managed as never to disfigure the patient, are not capable of afterwards taking the ſmall-pox infection—a fact which, if properly followed up, promiſes fair to extirpate the latter diſeaſe, to which more have fallen victims than to the peſtilence itſelf. Drs. Pearſon, Jenner, and Woodville, with a zeal that does them great honour, have ſince beſtowed much attention and labour in aſcertaining, by proper trials, how far it is prudent to perſevere in ſubſtituting a diſeaſe that has hitherto appeared no way dangerous, for one that ſo often proves mortal; and, we are happy to add, with a ſucceſs equal to the moſt ſanguine expectations that could have been formed: in conſequence of which, the following circular letter has been addreſſed to the gentlemen of the faculty:

Leiceſter Square, March 12, 1799.

Sir,

I hope you will pardon me for taking the liberty to inform you, by way of additional evidence to the teſtimonies I have publiſhed on the ſubject of the cow-pox, that upwards of one hundred and ſixty patients, from two weeks to forty years of age, principally infants, have been inoculated ſince the twentieth of January laſt by Dr. Woodville and myſelf ſeparately.—I ſhall at preſent only communicate the following obſervations:

1. Not one mortal caſe occurred.—2. Not one of the patients was conſidered to be dangerouſly ill.—3. Although the extreme caſes of the ſevere kind which ordinarily occur in the ſame number of caſes in the inoculated ſmall-pox did not occur in the above practice, and although many of the patients were even more ſlightly diſordered conſtitutionally, yet the whole amount of the conſtitutional illneſs ſeemed to be as great as in the ſame number of patients in the inoculated

lated small-pox.—4. None of the patients, namely, above sixty, hitherto inoculated for the small-pox, subsequently to the vaccine disease, took the infection.—5. One of the most important facts is, that the local affection in the inoculated part, on the whole, was less considerable, and of shorter duration than in the inoculated small-pox.—6. In many of the cases eruptions on the body appeared, some of which could not be distinguished from the small-pox.

I have sent the matter of the cow-pox pustule on the thread inclosed, in order, if you approve of the inquiry, to inoculate with it; and I entreat you to favour me with the result of your trials: but I must trouble you to apply the test of inoculating with variolous matter subsequently to the vaccine disorder.

I have the honour to be, &c. &c. &c.

G. PEARSON.

P. S. I am happy to be able to state, that at Berkeley Dr. Jenner has continued his trials of inoculation with vaccine matter, sent from London, with good success.—I should have given you a more circumstantial account of the cases here alluded to, but I think it unnecessary, as Dr. Woodville has a pamphlet in the press on the subject.

THE NEW INSECT.

IN our last we informed our readers that a new insect had appeared within these few years in this country, which threatens the entire destruction of all our apple-trees, if means be not generally followed for extirpating it. In the hurry of the press a material ingredient was omitted in Mr. Forsyth's recipe: we therefore reprint it more correctly.

℞. To 100 gallons of human urine and 1 bushel of lime add cow-dung to bring it to the consistence of paint. With this composition anoint the trees. The present is the proper season for applying it. If the white efflorescence-like substance in which the insects are lodged has made its appearance, it should previously be brushed off.

THE

PHILOSOPHICAL MAGAZINE.

APRIL 1799.

I. *Obfervations on Living Animals found inclofed in Stones and other folid Subftances.* By F. W. A. Murhard. *From* Magazin für das neuefte aus der Phyfik. *Vol. XI.*

OF living animals being found inclofed in folid maffes, I have met with no mention in the works of the ancients. Martial, indeed, in one of his epigrams, fpeaks of infects inclofed in amber; but thefe animals were dead, and therefore do not belong to this fubject. As far as I know, Fulgos * is the firft author who makes mention of a living toad being found inclofed in a ftone. He wrote about the beginning of the fixteenth century; and the circumftance took place in the village of Meudon in Italy, in the time of Pope Martin V. He was informed by a ftone-cutter that there was nothing furprifing in it, as fuch phenomena had often occurred to himfelf. Agricola, who lived afterwards, fpeaks of poifonous frogs being found in ftones, but which foon died when expofed for a fhort while to the air. Aldrovandi † alfo fpeaks of marble in which thefe animals were found

* See his work *De Mirabilibus.* Mediol. 1509, fol. and Antverp. 1565.8, in the chapter *De avibus animalibufque aliis admirandis.*

† Aldrovandi De Teftaceis, p. 81.

 alive,

alive. Ray * at first doubted the truth of these relations; but his doubts were soon removed by the undubitable testimony of eye-witnesses. Accounts of a similar kind may be found in Francisci's *Theatre of Various Curiosities*, printed at Nuremberg in 1671 †. The author there speaks of toads, crabs, serpents and shell-fish found in stones; but it is very evident that he confounds these with petrifactions.

Lloyd, in the third letter at the end of his *Lithophylacii Britannici Ichnographia* ‡, says, he was informed by Dr. Richardson that he had found a living toad inclosed in a solid rock. Dr. Bradley § mentions a fact of the like kind, having been witness to a toad being found in the trunk of a large oak. We are told in the History of the Academy of Sciences of Paris for the year 1719, that a toad was found inclosed in an elm as thick as a man's body. As soon as the trunk was cleft the animal dropped out, and no opening could be discovered through which it had got in to the heart of the wood. A similar circumstance is mentioned in the same work for 1731, viz. of a toad being found in an oak at least eighty or a hundred years old ||.

Labat, in his Travels through Spain and Italy ¶, gives a very minute description of a kind of shell-fish found in stones fished up from the sea in the territories of Civita Vecchia, and which were eaten by the inhabitants. "While walking," says he, "on the coast of Bichiere, I had the pleasure of seeing fished up several sea dates (*dattoli di mare*) which are produced and grow in certain stones of a some-

* Synopsis Animal. Quadruped. p. 21.

† Der lustigen Schau-Bühne vielerhand Curiositaten 2ter Theile durch Erasmium Francisci. Nuremberg, 1671.8. p. 1109.

‡ Lond. 1698.8, p. 107.

§ A Philosophical Account of the Works of Nature. Lond. 1721. 4to, p. 9 and 120. See also Acta eruditorum. Lip. 1721. p. 370.

|| See also Acta eruditorum. Lip. Suppl. VIII.

¶ Voyages en Espagne et en Italie. Amst. 1731.8. vol. iv. p. 240.

what

what ſpongy nature, found in great abundance in the Adriatic Sea, and of which there are ſome alſo in the port of Civita Vecchia. Theſe ſea dates, which are a kind of muſcles, are almoſt round, pointed at both ends, and conſiſt of two ſhells which open on one ſide, and are from one or two to nearly four inches in length. The ſhell is of the ſame quality as that of the common muſcle, but it is a little browner and leſs ſmooth on the outſide. The inſide has a ſomewhat ſilvery appearance. The fiſh which they contain is white, delicate, fat, and of a very agreeable taſte, ſo that it is a morſel for a cardinal (*un boccone di cardinale*). They are called dates, becauſe the ſhell which contains the fiſh has a great reſemblance to the dates of Barbary when they are ripe and dried. The ſtone in which they are incloſed is heavy and pretty ſolid, though it appears ſpongy. The cavity which the ſhell occupies in the ſtone, and which it exactly fills, touches it on all ſides like the beſt fitted caſe. Some ſmall ones are not half an inch in length, but others are four inches. When the fiſhermen had procured a ſufficient number of the ſtones, they placed them on the edge of the quay, and broke them by means of a large hammer. In ſome they found nothing, but others contained two or three dates. They gave ſome of them to me, together with fragments of the ſtone which incloſed them, and on which I made the above obſervations."

Inſtances of a ſimilar kind may be found alſo in various other works. Thus we are told that Charles Hall, a merchant at Eberach, ſaw a living toad ſitting in a ſtone, upon its being broken. Martin Weinreich * relates a circumſtance of the like kind; and John Nardius † ſays, that he found in a block of marble a living ſnake. Libavius ſpeaks of vipers and toads found in ſtones, as does alſo Cardan. A living

* Commentar. de Monſtris, cap. vii. p. 58.

† Joan. Nard. in Ann. 1. noct. gen. 4. p. 266.

toad was found in an oak by Seigne in 1731, and another in a hard ſtone, at Ecretteville, by Le Prince in 1756 *.

A great many particulars relating to this ſubject have been collected by Guettard. A common toad, two of whoſe feet were free, and the other two ſticking faſt in gypſum, ſo that it was impoſſible to diſengage them without tearing them to pieces, was ſent to him by order of the Duke of Orleans. Count Hermann II. of Hatzfeld, told Dr. Sachſen † that he heard a living frog croak in the middle of a ſtone at his palace of Schellenberg, near Cologne, and that the animal hopped out on the ſtone burſting of itſelf. I ſhall now give a few other inſtances, of which Guettard makes no mention.

In the year 1733 a living toad was found by J. M. Gräberg in a ſolid hard block of ſtone, dug up from a quarry in the pariſh of Wamblingebo, in Gothland, and which he cauſed to be broken by the workmen. The colour of the animal was blackiſh grey, a little ſpotted on the back, and ſomewhat fainter on the belly. Its eyes were ſmall and round, and covered by a tender ſkin or film, under which they ſeemed to ſparkle a little with a colour like that of pale gold. Having touched it on the head with a ſtick, it contracted its eyes as if it had been aſleep: as ſoon as the ſtick was removed, it gradually opened them; but moved neither its body nor feet in the leaſt, though he touched it different times. He remarked alſo that the mouth had no aperture. It was covered with a yellowiſh ſkin, which he examined alſo with the ſtick, but he was not able to make it

* Inſtances of the like kind may be found in the following works: *Haller de corp. hum. fabr. et funct.* vol. vii. p. 157; *Avant Coureur*, 15 Sept. 1766; *Ch. Franc. Paullini in Bufone*, c. 3. *ſect.* i. p. 33; *Chriſt. Fr. Garmann in Oolog. curr. diſs.* ii. p. 145. § 120; *Nierenberg. Hiſt. Nat.* lib. vi. c. 13; *D. Bauſchius de Actite*, p. 74; *Euſeb. Chriſt. Frankens Hiſtorie der Grafſchaft Mannsfeld*, Leip. 1723. vol. i. ch. 5; *Leſſers Lithotheologie*, Hamburgh 1751.8, p. 101 and 112.

† Memoires ſur differens parties des Sciences et des Arts. Paris 1783.4. vol. iv. p. 615.

open

open it. Having at laft preffed it on the back, a little clear water iffued from it behind, upon which it immediately died*. Don Antonio de Ulloa, who with Condamine, Bouguer and Godin, was employed in meafuring a degree of the meridian in Peru, faw at Madrid two worms which had been found in the middle of a block of marble by the king of Spain's ftatuary. Miffon, in his Travels through Italy, fpeaks of a living crab found in a piece of marble near Tivoli. M. Peyfonnel, phyfician to the king of France, having employed fome workmen to dig a well near his houfe in Guadaloupe, they found living frogs amidft the ftrata of the rock. His curiofity being excited by this circumftance, he defcended into the well himfelf, bored into the rock, and brought up alive fome green frogs, which had a perfect refemblance to the common ones.

In the Gentleman's Magazine for 1756 mention is made of a living toad found in a block of marble, at an old caftle belonging to Lord Tankerville, twelve miles north-weft from Alnwick †. T. Whifton relates, that in the year 1743 a ftone-cutter named Charlton found near Wifbich, in the Ifle of Ely, a living toad inclofed in a piece of marble ‡. Being called to the fpot, he faw the animal, and the cavity in which it was contained. The latter was fomewhat larger than the toad, and had almoft the fame figure. The animal was of a dark yellow colour; and the folid marble, which inclofed it on all fides, was feveral inches thick. It feemed to be quite healthy, and by its long confinement had not become meagre. John Malpas alfo, in the year 1755, found a living toad inclofed in a piece of free-ftone at Great Yarmouth §. The hole in which it lay was fix inches diftant from the corner of the ftone. He took it out with a pair of

* Kongl. Swenfka Vetenfkaps Academiens handlingar for är 1741. p. 248.

† Gentleman's Magazine, 1756, p. 74.

‡ Ibid. May 1756, p. 240.

§ See Gentleman's Magazine, loc. cit.

compasses, but in doing so happened to hurt it. When he placed it on the ground it however crept about, but died in the course of an hour. It had a yellow stripe over the back, the colour of which became changed after it was dead. No crack or cleft could be discovered in the stone. The inside of the cavity was smooth, and looked as if it had been polished.

M. Gerhard, at Padenburg, in the county of Mansfeld, saw likewise a living toad inclosed in a stone. The cavity in which it lay seemed exactly fitted to the size of the animal, but was exceedingly smooth in the inside. No opening could be observed through which it was possible for it to have got into the stone. After some search, however, a hole was discovered at the surface of the earth, which extended to the depth of twelve toises; but ceased at the distance of thirteen inches above the cavity that contained the toad. M. Gerhard considers it as very probable that this aperture had formerly extended to the cavity, into which the egg of a toad might have been conveyed by water; and that the opening must afterwards have been closed up near the cavity. The toad, however, must have remained long in this state; for such apertures do not close up soon, and a long time is required for the petrifaction of earthy particles *.

M. le Cat †, who relates many instances of the like kind, examines the possibility of them, and the causes of such phenomena. Some philosophers have been of opinion, that the eggs of these animals, created by the Supreme Being at the beginning of the world, and floating about on the watery expanse, have since that time been inclosed in the interior parts of the rocks. But M. le Cat contradicts this opinion by remarking that the creation of an egg is not sufficient, and that it must be hatched in order to produce a living creature. He considers it also as impossible that such ani-

* See Nouveaux Memoires de l'Acad. des Sciences et Belles Lettres de Prusse pour l'année 1782. Berlin 1784, 4to. p. 13.

† In Du Lac Melanges d'Histoire Naturelle, vol. iv. p. 615.

mals

mals can be of the same antiquity as the stones or substances in which they are found. The age of the oldest men, says he, never exceeded 169 years; and what is the life of an insect when compared with that of man? Even if we suppose that the moderation of these animals, and their being exposed to very little motion, had caused their growth and the periods of their life to be extended in an uncommon degree; and though their want of air, or rather their being preserved and defended from the manifold impressions of that corrupted element, had contributed a great deal to their support, the prolongation of life thence arising could not exceed so very much their natural and usual existence. M. le Cat rather thinks that a hatched egg, in all the cases mentioned, may have fallen by chance into some small cavity, where it was secured from petrifaction till its substance acquired sufficient strength. He here remarks that eggs, when rubbed over with varnish so as to be defended from the effects of the air, may be preserved fruitful for years; and he therefore believes, on good grounds, that an egg so secured in the centre of a rock might retain its activity for some thousands of years, and even that it would be impossible for it to be hatched till it had been exposed to a very high degree of often renewed or long continued heat. According to M. le Cat's opinion it is the egg which is of great antiquity, and not the animal. I shall here observe that nature, when allowed peace and rest, does not require so much time as is generally believed in order to produce minerals. Of the truth of this remark I am fully convinced, since I saw in the museum at Göttingen the step of a ladder found on clearing the gallery of a mine in Rammelsberg, abandoned at most about 100 years before, and which in the course of that period had been encrusted with selenite seven inches in thickness. Nay we have instances of ore having grown up in a much shorter time *.

* See *Ulloas Nachricht von America*, vol. ii. p. 14, and *Trebras Erfahrungen vom Innern der Geburge*, p. 53, tab. 4, no. 4.

I must observe also, that most of the animals found in this manner were of the amphibious kind, and request the reader to reflect on the habits, nature and mode of living peculiar to that class. Caldesi relates, that tortoises can endure hunger for half a year; and numberless instances might be produced of their strong and tough nature.

I shall not enlarge farther on this subject at present, as I mean at some future period to communicate my ideas to the public in a more connected manner, and to give as complete a theory on it as possible. I flatter myself that I am the more qualified for this task, as many have written on these phenomena and formed conjectures without having ever seen one instance, while I have been an eye witness of some of the latest. In a quarry not far from Cassel, between that city and the palace of Freyenhagen, I found three toads together in a pretty large block of free-stone *. I remember, also, that, when a boy, our house at Cassel being under repair, and the old plaster pulled down, several toads were found between it and the stone wall †.

At a period like the present, when so many things are made the subject of experiment, when every one endeavours to tread in the footsteps of a Bacon and a Newton, and, instead of being contented with surveying Nature in her private recesses and carefully watching her progress, compels her as it were to labour and make known her secrets, I am much astonished that she has not been put to the proof in this respect long ago. Such experiments, without which all theory must ever remain mere hypotheses, and can never amount to demonstration, would require little or no expence. Nothing would be necessary but to make a deep hole in a stone; to inclose some animal in it, such for example as a

* See Diss. Academicor. Institut. Bonon. (interp. Beccario) op. Benedict. XIV. P. M. de Sevor. Dei beatificat. l. iv. p. 1. p. 328; and Beccarius in Commentar. Instit. Bonon. tom. ii. p. 1. p. 323.

† A full account of this circumstance, which I transmitted to M. Kastner, may be found in the *Gottingisch. Anzeig.* for 1796.

toad, and to prevent the air from penetrating to it: or eggs only might at firſt be put into the ſtone. It would, however, be attended with moſt advantage if ſeveral experiments were made at the ſame time, in order that the ſtate of the animals might be examined at different periods. Such experiments, and careful obſervation of the nature and economy of theſe animals, could alone lead to any certain concluſion reſpecting a circumſtance ſo abſtruſe, which, at preſent, ſeems to ſurpaſs the powers of our comprehenſion.

II. *Obſervations on Snow and Rain; their Influence on Vegetation, and their Combination with Oxygen.* *By* J. H. HASSENFRATZ.* *From* Journal de L'Ecole Polytechnique, *P. IV.*

ALL thoſe who inhabit parts of the earth expoſed to ſnow, agree in conſidering this meteor as one of the means employed by nature to give to plants more ſtrength, and to make them expand with more vigour. Several even are perſuaded that winters which produce no ſnow preſage a bad harveſt and a feeble ſtate of vegetation; and they aſcribe its influence to the ſalts which they ſay exiſt in that congealed water. Snow collected in large maſſes, melted and evaporated in earthen veſſels, having left no reſiduum, has made this ſuppoſition be conſidered as a mere chimera; and, in conſequence of reaſoning carried too far, ſome have been induced to deny that ſnow has any influence at all on vegetation.

In phenomena tranſmitted through ſucceſſive generations, we muſt diſtinguiſh the reſults of obſervation from the explanations ſome have attempted to give of them. There are phenomena, indeed, the whole of which preſent themſelves to our ſenſes in their full force, and which can leave no doubt in the mind of the leaſt attentive obſerver; but there are others which exhibit only a few traces that cannot be difdiſtinguiſhed, unleſs by particular inſtruments, or after a ſeries of obſervations often repeated. When theſe traces have been obſerved by a great number of individuals, for ſeveral generations, however incorrectly tranſmitted, and however obſcure may be the tradition, the philoſopher muſt beware of deciding too raſhly. The greater the number of obſervers, the more perfect is the uniformity of their opinions reſpecting the phenomenon, and the more careful ought people to be in their diſcuſſions before they venture to contradict them.

The influence of ſnow on vegetation has been ſubjected to the examination of too many obſervers, to allow us to believe it poſſible that there could be ſo great an uniformity in their opinions, were not the effects really ſuch as are ſuppoſed. In this memoir, then, I ſhall examine theſe effects; I ſhall endeavour to explain the cauſe of them, and ſhall enquire what relation there is between the explanation given long ago by farmers and a more accurate analyſis of ſnow.

That, after a very cold and very ſevere winter, vegetation is ſtronger and more active in proportion as plants have been covered with a greater depth of ſnow is a certain fact, proved by the reſult of the experience of every one engaged in agriculture. The cauſe is ſimple and natural. All plants are capable of ſupporting cold in a leſs or a greater degree; there are ſome which cannot be expoſed to the temperature of melting ice without periſhing, and there are others on which the moſt intenſe cold produces no alteration. Each plant then has certain limits to its reſiſtance of cold; a certain temperature beyond which it cannot be expoſed to it without the danger of being frozen and deſtroyed. Several plants expoſed to a temperature nearly equal to that which muſt congeal them do not periſh, but, by the ſharpneſs of the cold which they experience, contract a languiſhing diſeaſe, the effects of which they feel during the whole courſe of their exiſtence.

If we expoſe to the action of great cold a ſeries of plants capable of ſupporting different degrees of it, there will periſh in that ſeries a greater number in proportion as the cold has been greater; but if, by means of a covering, we intercept the cold, and prevent the plants from being expoſed to a diminution of heat as great as that which exiſts without, ſeveral plants which would otherwiſe have periſhed will be preſerved; ſeveral of thoſe which would have been diſeaſed will be healthy and vigorous, and their number will be greater in proportion as the covering has intercepted a greater degree of cold.

The earth has a heat accumulated in its interior parts: this heat is perceived in all ſubterranean places of ſufficient depth to prevent the external cold or heat from penetrating thither. This temperature is equal to 13° on the decimal ſcale of the mercurial thermometer (55·4 Fahr.). Snow is a bad conductor of heat; cold penetrates it with difficulty, and its temperature when it melts is zero. When the ſurface of the earth is covered to a conſiderable depth with ſnow, the cold of the atmoſphere, in contact with it, tends to cool its maſs; and the internal heat of the earth tends to warm it. Through the maſs of ſnow there is then a conteſt of heat and cold, the uſual reſult of which is to melt a portion of the ſnow, and to carry to zero the temperature of the middle, in which the plants are ſituated.

Thus ſnow has the property of keeping the plants which it covers at the temperature of melting ice; of preſerving them from the influence of a greater cold; of ſupplying them with continual moiſture; of preventing a great number from periſhing, and ſtill more from languiſhing; and, conſequently, of giving more ſtrength and vigour to vegetables than they would have obtained had they not been covered with ſnow. It appears then that we may explain a part of the influence which ſnow has upon vegetation, without having recourſe to the ſalts or nitre which it is ſaid to contain, and which analyſis and experiments have proved do not exiſt.

The explanation of the influence of ſnow by the continual humidity it ſupplies to plants, is the reſult of obſervations which cannot have eſcaped intelligent farmers in all ages; but a knowledge of the influence it has by being a bad conductor of heat, is the conſequence of experiments recently made on caloric. The ancients had neither a ſeries of facts nor inſtruments proper for ſuch reſearches. They obſerved, that the atmoſphere ruſted metals in the ſame manner as acids; from which they concluded, that the air contained an acid. They remarked, that nitre was formed ſpontaneouſly on calcareous maſſes; from which they concluded, that the acid of the atmoſphere was a nitre: and this concluſion was not far from the truth, ſince the lateſt experiments, and moſt remarkable diſcoveries which have contributed in the higheſt degree to the rapid progreſs of phyſics, have proved that the air is formed of two elements, which enter into the compoſition of the nitric acid, viz. oxygen and azot. Let us acknowledge, therefore, that the philoſophers who preceded us poſſeſſed no little acuteneſs and ſagacity to be able to diſcover, ſo long ago, by the accumulation of ſeveral indirect experiments, what the moſt accurate analyſis demonſtrates at preſent.

If ſnow poſſeſſed only the property of preſerving vegetables, and of preventing them from periſhing by the ſeverity of the cold, it is not at all probable that the ancient philoſophers would have conſidered it as depoſiting on the earth nitrous ſalts, as they might have aſcertained, by a very ſimple experiment, that it contains none of that ſalt; for they did not aſcribe the ſame property to rain-water, but they remarked that ſnow burnt the ſkin in the manner of acids, as well as other bodies immerſed in it. Being induced to conclude that there was nitre in the air, it was natural that they ſhould aſcribe to this nitre the burning qualities of ſnow, and conſequently its influence on vegetation.

C. Guyton having engaged me to examine the cauſe of the difference of the effects of ſnow and rain-water on various

rious fubftances, I found that they were occafioned by the oxygenation of the fnow; and that thefe effects were to be afcribed to a particular combination of oxygen in this congealed water. I put 1000 grammes of fnow in a jar, and 1000 grammes of diftilled water in another. I poured into each of the jars an equal quantity of the fame folution of turnfole. I placed both the jars in a warm temperature, and, after the fnow melted, I remarked that the dye was redder in the fnow water than in the diftilled water. I repeated this experiment, and with the fame refult. I put into a jar 1000 grammes of diftilled water, and into another 1000 grammes of fnow. Into each of the jars I put 6·5 grammes of very pure and clean fulphat of iron. In the firft there was precipitated 0·150 grammes of the oxyd of iron, and 0·010 grammes in the other. As the oxyd of iron was precipitated from a folution of the fulphat by oxygen, it thence follows, that the fnow contained more oxygen than the diftilled water; and it follows from the firft experiment, that this quantity of oxygen was confiderable enough to redden the tincture of turnfole.

It is fully demonftrated by thefe two experiments, that fnow is oxygenated water, and that it muft confequently have on vegetation an action different from that of common ice. The experiments of Dr. Ingenhoufs, on the germination of feeds, have taught us that the prefence and contact of oxygen are abfolutely neceffary for the plant to expand. They have fhewn alfo that the more abundant the oxygen is the more rapidly will the feeds grow. Moft plants fuffered to attain to their perfect maturity fhed on the earth a part of their feed. Thefe feeds, thus abandoned and expofed to the action of cold, are preferved by the fnow which covers them, at the fame time that they find in the water, it produces by melting, a portion of oxygen that has a powerful action on the principle of germination, and determines the feeds that would have perifhed to grow, to expand, and to augment the number of the plants that cover the furface of the earth.

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A very confiderable number of the plants which we have the art of appropriating for our nourifhment and our wants are fown in the months of Vendemiaire, Brumaire, and even Frimaire (end of September to end of December); feveral of thefe feeds germinate before the cold commences its action upon them and changes the principle of their life. The fnow which covers the reft, acting on the germ by its oxygenation, obliges them to expand and to increafe the number of ufeful plants which the farmer and gardener commit to the earth, and confequently to multiply their productions.

Here then we have three effects of fnow upon vegetation, all very different, which contribute each feparately to increafe, every year, the number of our plants; to give them more vigour, and confequently to multiply our crops. Thefe effects are: 1. To prevent the plants from being attacked by the cold, and from being changed or perifhing by its force. 2. To furnifh vegetables with continual moifture, which helps them to procure thofe fubftances neceffary for their nutrition, and to preferve them in a ftrong healthy ftate. 3. To caufe a greater number of feeds to germinate, and confequently to increafe the number of our plants.

Before I conclude, I muft mention fome important experiments, in regard to vegetation, which I made on rain-water. Rain-water does not act on tincture of turnfole or on fulphat of iron like fnow; from which it would appear that it does not participate in that property which it acquires by oxygenation. Rain-water, however, contains oxygen alfo; but in a ftate of folution, and not of combination, as in fnow; for under an exhaufted receiver rain-water fuffers air to efcape from it, which contains proportions of oxygen much greater than river water, fpring water, and even atmofpheric air.

Atmofpheric air expofed to the action of phofphorus, without the application of heat, after the method indicated by Berthollet, is diminifhed in its bulk 0·20; that is to fay, the phofphorus takes from the azot 20 parts of oxygen in

100

100 parts of atmoſpheric air. Air drawn from the water of the Seine, tried by the ſame eudiometer, gave the ſame diminution. Air drawn from rain water was, on the other hand, diminiſhed by phoſphorus from 0·32 to 0·40. As the mean of a great number of experiments was 0·35, it thence follows that the proportion of oxygen in the air obtained from rain water, newly fallen, is greater and more conſiderable than that contained in atmoſpheric air, and in the air of other water.

Since rain water thus differs from common water by the oxygen it holds in ſolution, and ſince oxygen has an influence on germination, and even on vegetation, as is proved by the experiments of Ingenhouſs and Senebier, it is natural to aſcribe to it a part of the peculiar action which rain has on the vegetation of plants different from that of other water with which they are watered.

III. *On the Component Parts of Iron-ſtones, and how theſe in the manufacturing affect the Quality of Crude Iron. By* Mr. David Mushet, *of the Clyde Iron Works. Communicated by the Author.*

[Continued from page 210.]

Having in the former part of this paper ſtated the average loſs which the various natures of iron-ſtones ſuſtain when expoſed to torrefaction in external air, I ſhall now ſimply ſtate the quantity of oxygen which the various claſſes are apt to imbibe when expoſed to a high temperature, after thoſe volatile mixtures capable of aſſuming the gaſeous ſtate by the combination of caloric have been expelled.

The facility with which iron-ſtones become oxydated is entirely dependent upon the nature of the mixture conſtituting fuſibility or otherwiſe: ſo that were argillaceous, calcareous, and ſiliceous iron-ſtones, previouſly de-oxygenated, expoſed to the ſame degree of heat—a degree capable of oxydating their iron—the reſult would be, that the quantity of oxygen combined would be in a relative proportion to the fuſibility

fuſibility of the mixtures, for a determinate ſpace of time. The argillaceous iron-ſtone would be found in a given time to have gained leaſt; the calcareous a larger portion; while the ſiliceous, containing an aſſemblage of mixture fuſible at a degree of heat in which the former would remain unchanged, will be found to have gained the greateſt weight; but if expoſed to an high temperature for a ſufficient length of time, the oxygen abſorbed will be in an exact proportion to the iron contained in the ſtone; only, the ſiliceous iron-ſtones arrive ſooneſt at a high pitch of combination. In the courſe of many experiments I have found the following proportions to be nearly juſt, when the quantity of iron contained in the reſpective ſtones was nearly analogous.

Argillaceous iron-ſtone, which has yielded me 38 per cent. in the aſſay-furnace, firſt diſtilled and afterwards carefully de-oxygenated, increaſed in weight, during an expoſure to ignited gas for 8 hours in the bottom of a deep crucible, 22 per cent.

Calcareous iron-ſtone, which afforded a ſimilar quantity of metal, and which was ſubjected to the ſame train of preparation, to diſpel its volatile mixtures, and unfix its oxygen, gained in weight nearly 23 per cent.

Siliceous iron-ſtones, containing from 36 to 38 parts of iron in 100, treated in the ſame manner, afforded me inſtances of an accumulation of weight equal to 24 to 25 per cent.

In order more particularly to illuſtrate the double phenomenon of iron-ſtones firſt loſing and then gaining weight, I ſhall inſert the treatment of one particular ſtone of each claſs; from which a poſitive judgment may be formed of the general operation, and reſults, peculiar to each.

1. There were introduced into an iron teſt ſome pieces of argillaceous iron-ſtones, weighing - - 1750 grs.

After being expoſed to a bright red heat for 8 hours, and then allowed to cool, they weighed 1160

Loſt in ſimple diſtillation - - - - 590 grs.

Equal to 33·6 per cent. Specific gravity in this ſtate 2,52150.

The

The ſtone had now aſſumed a claret colour, and was poſſeſſed of regular internal fibres, adheſive to the tongue, obedient to the magnet, and exhibiting every property peculiar to excellent iron-ſtone.

I returned the reſidue, which, as above, weighed 1160 grs. and expoſed it in an open crucible for 4 hours to an increaſing heat till a ſlight degree of fuſion was perceived to take place. This was indicated by the angles of the pieces becoming rounded, and ſwelling a little in bulk—When cool they were found ſlightly porous, and weighed - 1309

Increaſed in weight by the combination of oxygen - - - - - 149 grs.

Equal to 12·8 per cent. Specific gravity in this ſtate 3·3636.

The fracture of the pieces now wore a ſemi-vitrified appearance, of a dark blue colour, refractory to part, inadheſive to the tongue, unmagnetic, but much more metallic and ponderous. A calcareous iron-ſtone treated after the ſame manner, of which I alſo uſed ſmall pieces, weighing - - - - - - 1750 grs. which had yielded a ſimilar product in iron in the aſſay-furnace with the former, when cool weighed - - - - - 1090

Loſt in ſimple diſtillation equal to 37·7 per cent. - - - - - 660 grs.

The fracture of this iron-ſtone was now of a bright brown colour, ſtreaked with lime, faintly marked with internal fibre, leſs tenacious to the tongue than the former claſs, but equally obedient to the magnet.

The reſidue, weighing as above - - 1090 grs.
was returned to the furnace, and expoſed in the bottom of a deep crucible, till ſuch time as a ſlight indication of fuſion was obſerved; when cooled, the pieces weighed - - 1235

Gained in weight by the fixation of oxygen equal to 13·3 per cent. - - - 145 grs.

In its preſent ſtate this iron-ſtone, in point of colour, reſembled the former.

Its fracture, however, was ſmoother, and more vitrified, equally deſtitute of tenacity to the tongue, and obedience to the magnet.

3. An iron-ſtone, which contained a large proportion of ſand, was expoſed under ſimilar circumſtances to the ſame degree of heat—Quantity uſed weighed alſo - 1750 grs.

When properly torrefied, weighed - - 1248

Loſt in ſimple diſtillation equal to 28·6 per cent. - - - - - 502 grs.

The appearance which this ſtone had aſſumed was of a reddiſh, ſmall, granulated fracture, conſiderably magnetic, but ſcarcely poſſeſſing any degree of adheſion to the tongue.

The reſidue, weighing as above - - 1248 grs.
was expoſed to an equal degree of heat with the former claſſes, by which the ſtone ſuffered throughout a ſlight degree of fuſion—when cool, the connected maſs weighed - 1431

Gained in weight by the combination of oxygen equal to 14·6 - - - 183

The colour of the ſtone was now changed to a black, vitreſcent, ſlightly porous maſs, hard and refractory. I have not given the ſpecific gravities of the two laſt natures of ſtones: iron-ſtones containing equal portions of iron, in ſimilar ſtates of preparation, vary little in their ſpecific gravities.

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It will no doubt be obſerved, that the increaſe of weight in theſe ſtatements tally not with the ſums formerly given: the amounts there adduced are reſults from iron-ſtones which had been previouſly deprived of moſt of their oxygen; but in theſe, the extra quantity of oxygen taken up by the ſtone is only given, forming an aggregate, with the original exiſting quantity, as ſhall hereafter be ſhown, nearly correſponding to the ſums firſt given.

From theſe experiments, ſingled out to convey a juſt idea of the changes to which iron-ſtone may be ſubjected, it becomes obvious, that all the varieties of iron-ſtone are capable of decompoſing atmoſpheric air at a certain temperature, and of fixing a portion of its oxygen, whereby weight is gained, by each, nearly equal to 1-8th of its original quantity.

It muſt alſo from this appear obvious, that the burning of iron-ſtone is an operation—though hitherto conducted by chance, expoſed to all weathers—of the greateſt nicety, and conſequence to the certain and economical manufacture of caſt-iron; wherein a ſmall addition of fuel, by exciting a high temperature, expoſes the iron to the combination of a hurtful principle, in quantity (as will hereafter be ſhown) almoſt equal to what the metal was originally precipitated in. The extra proportion of fuel, therefore, requiſite under circumſtances where a ſevere mode of torrefaction is either univerſally adopted, or where it is frequently the reſult of inattention and want of ſkill, though as yet unaſcertained upon a large ſcale, muſt be very conſiderable.

I look upon it therefore to be a great deſideratum in the preparation of iron-ſtone, to contrive a mode which would unite certainty and economy; a mode which would either de-oxygenate the ore unexpoſed to external air, or which would diſſipate its volatile mixtures expoſed to air, with a degree of certainty which, with a ſmall ſhare of attention, would preclude the poſſibility of the metal attracting more oxygen.

In the preſent mode of preparing iron-ſtones, too much is left to chance and the diſcretion of ſubordinate workmen. The ſurface of the piles, being always in contact with the open air, is frequently expoſed to perforations from winds, eſpecially in thoſe parts where the layer of ignited coals comes in contact with the current: a hollow ſpace is ſoon formed; the fuel, by means of the freſh air continually pouring in, becomes ignited to whiteneſs; the ſurrounding ſtone is immediately fuſed: ſhould this aperture be joined by a ſimilar communication from oppoſite ſides of the fire, a degree of heat will be excited beyond what could have been conceived poſſible in this mode of burning, and oxygen be combined with a maſs of ſtone in ſuch an high proportion as to form a very conſiderable part of the whole weight. This is an accident which will take place even where order, regularity and experience are conſpicuous: were it poſſible to avoid it by torrefying the iron-ſtone in that juſt temperature which has been formerly demonſtrated as the moſt proper, uniting at ſame time an equal degree of economy, it would contribute greatly to reduce to certainty and rule the operations of the ſmelting-furnace.

The extreme of fuſing the materials, and combining the iron with an extra portion of oxygen, is not the only evil which an accurate mode of torrefaction would avoid: the ſame train of caſualty often affords a conſiderable portion of the ſtone not enough prepared, and ſome quite untouched by the fire. The effects produced by iron-ſtone in this ſtate are exactly ſimilar to thoſe experienced in the former, ariſing from the ſame cauſe, but exiſting as the reſult of two oppoſite extremes.

I confeſs it is much eaſier to point out the faults of an eſtabliſhed mode of practice, than to ſubſtitute one, which, though it might unite ſome ſuperior advantages, yet might not combine an equal number upon an extended ſcale. I have frequently conſidered the ſubject, and have as often been impreſſed with the truth of its importance in the manufacturing

nufacturing of iron. At ſome future period I may ſubmit to the manufacturers of iron a double method of preparing iron-ſtones for the blaſt-furnace; in which, certainty of operation would be obtained, and in the end moſt probably a degree of economy inſured equal to that of the preſent mode.

I would effect this by expoſing the iron-ſtone ſtratified with a ſmall proportion of coals, in ſimply conſtructed ovens, entirely covered on the top, except a few ſmall funnels to carry off the ſmoke and diſengaged vapours; the ignition to be occaſioned by a current of flame paſſing under a flue in the bottom of the furnace, and conveying combuſtion to the ſub-ſtratified coals. As this operation could be conducted to a phyſical certainty by means of damping the furnace inſtantaneouſly, as ſoon as the vapour, &c. had ceaſed, or as ſoon as complete ignition had pervaded the contents, (the duration to be determined by the nature of the iron-ſtone,) the reſults in this caſe could at all times be depended upon, and the preſent irregular products avoided. A ſecond method of depriving iron-ſtones of their volatile mixtures would be to expoſe them to a conſiderable degree of heat, in contact with the duſt of pit-coal coaks—as being the moſt economical—ſhut up from the admiſſion of external air. This would not only deprive them of their acid water, &c. but would alſo unfix moſt of the oxygen combined with the metal, and afford the iron nearly in a diſengaged ſtate. Both theſe methods, however, at the preſent time, want the ſanction of approving practice, on an extenſive ſcale, to render them uſeful, or worthy of univerſal attention.

De-oxygenation of Iron-ſtones.

This proceſs has been long known in part, and its principles (ſo far as underſtood) applied by the metallurgiſt to deprive the ore, ſubjected to the aſſay-furnace, of its oxygen, in order that the metal might become revived. Its operation is however much more extenſive than what has hitherto

 been

been conceived; and its reſults afford the moſt beautiful and intereſting phenomena known in the art of manufacturing iron.

De-oxygenation in the caſe of iron-ſtones will admit of being divided into three diſtinct ſtages, all of which tend to the ſame final reſult.

1. That wherein iron-ſtone is found to have loſt its water of cryſtalliſation and continuity of fracture; to have aſſumed a greyiſh white colour, ſoft and pulverulent; and greatly ſpecifically lighter than formerly, having loſt from 2-5ths to 9-20ths of its original weight.

2. That ſtage wherein the pieces have aſſumed the ſtate of malleability, and have again become firm and connected; wherein they brighten under the file; and, when ſubjected to the hammer, under various degrees of heat, receive impreſſions at pleaſure, and draw into ſhape.

3. That ſtage wherein, by prolonging cementation, the pieces of iron-ſtone are found to have paſſed into the ſtate of ſteel; poſſeſſing all its properties, though difficult to ſeparate from the earthy parts, and preſerve its quality; but which may be precipitated from the ſteelified ore by fuſion, in the ſtate of caſt-ſteel, by means of the aſſay-furnace.

Theſe three diſtinct ſtages of de-oxygenation are produced by a continuation of the ſame cauſe to which all iron-ſtones may at pleaſure be ſubjected. With primary ores, richer in iron, the reſults are more certain, ponderous, and much better ſuited to operate upon, for the production of good malleable iron and ſteel: theſe are almoſt univerſally capable of being de-oxygenated, for the production of both theſe modifications of the metal. I have met with no exception, indeed, but in the caſe of a few granulated Norwegian ores, a blue ſpeckled Daniſh ore, a few Ruſſian bog ores, and the Scotch ore of the iſland of Iſlay.

In the preſent paper I ſhall confine myſelf to a minute detail of the firſt ſtage of de-oxygenation; the ſecond and third ſtages, as they more immediately belong to the manufacture

of

of iron and ſteel, ſhall be fully conſidered in connection with this curious mode of manufacturing theſe ſtates of the metal from ores without fuſion, which, from its novelty and ſimplicity, deſerves a thorough inveſtigation of operation and principle.

De-oxygenation ſimply conſiſts in expoſing iron-ſtone or ore, ſtratified with coaly matter, ſuch as the duſt of pit-coal coaks, or the charcoal of wood unexpoſed to air, at a high temperature. The oxygen contained in the ore is taken up by the charcoal, and paſſed off in the ſtate of carbonic acid; while the water, carbonic acid, &c. previouſly exiſting in the ſtone, is evaporated by the addition of caloric. In proportion as the ore becomes cleared from theſe mixtures, the metal becomes more and more revived, approaching however to the ſtate of malleable iron, though ſtill interſperſed with the original quantity of earthy parts united in the ſtone. By increaſing the temperature, and continuing its duration, the particles of iron unite, and form themſelves into fibres, which, even when cold, may be twiſted and bent a little; ſtill however having the original quantity of earthy matter almoſt inviſibly interpoſed betwixt their interſtices. If the heat is urged ſtill further, the iron, now malleable, begins to take up a portion of the carbon from the charcoal, and the metal then commences its change to ſteel.

During any part of the proceſs, ſhould air come in contact with the ore, by previouſly deſtroying the ſurrounding charcoal, an immediate oxydation of the iron takes effect, proportioned in its increaſe of weight to the ſtage of the operation at which it is effected. The ore has then paſſed into a friable, bulky, and unmetallic ſtate.

In de-oxygenating iron-ſtones, with an intention of diſcovering and of eſtabliſhing an analogy as to the quantity of oxygen contained in the reſpective claſſes of ſtones, I was frequently led to conclude, that argillaceous and calcareous iron-ſtones contained leſs oxygen than iron-ſtones where a greater proportion of ſilex predominated. Though by far the greater number of experiments performed on this ſubject were in favour of ſuch an inference, yet I have at times experienced my arrangement palpably contradicted, without being able to ſolve the obtruding difficulty. I ſhall not however deſpair, in moſt caſes, to reduce to certain invariable inherent properties, and external characteriſtic forms, the various iron-ſtones in the manner in which I have arranged them, and conſonant to the reſults obtained from them in the proceſs of manufacture. The utility of ſuch an arrangement, founded upon experiment, muſt be obvious and ſtriking: it will give certainty and value to the various products of the manufacturer, as it will in the end ſyſtematize the manufacture itſelf, and reduce it to rules guided by principle, and not by the aberration of a falſe or miſinformed judgment.

From many experiments I have made with all the varieties of iron-ſtones found in this country, I ſhall ſubjoin the treatment of one of each claſs, highly marked with the predominating earths, that an accurate opinion may be formed of the phenomena exhibited in this part of the proceſs.

I. I uſed a fine argillaceous iron-ſtone, in ſmall pieces, weighing - - - - - 1750 grs.

After a proper diſtillation of 8 hours in a degree of heat equal to 30° of Wedgewood, I obtained a fine purple-coloured fibrated iron-ſtone, which, when cold, weighed - - - - 1160

Loſs of water, acid, and ſulphur, equal to 33·6 per cent. - - - - - 590 grs.

The influence which the magnet poſſeſſed over this ſtone was conſiderable; the adheſion to the tongue was however great.

I next introduced into a proper veſſel, in contact with charcoal.

charcoal-duſt, ſome pieces fractured from the ſame original maſs; they alſo weighed - - - 1750 grs.

After expoſure for 14 hours to a degree of heat equal to 120° of Wedgewood, the iron-ſtone, being carefully ſeparated from the charcoal and dried, weighed - - - - 1002

Loſs of water, acid, ſulphur, and oxygen - 748 grs.
Loſt by ſimple diſtillation - - 590

Oxygen taken up by the charcoal, equal to 9 parts in 100 - - - - 158 grs.

This muſt not, however, be taken as the total meaſure of oxygen combined with the iron, but only that portion taken up in the firſt ſtage of the operation; which, as it poſſeſſes the following properties, fully entitles it to this diſtinction:

1. The iron-ſtone, from being firm and compact, poſſeſſing ſpecific gravity from 3 to 3·5, now becomes comparatively light, friable, and pulverulent; ſpecific gravity, from 2·1 to 2·5. It now moulders with a ſlight preſſure, and is eaſily reduced to fine powder of a whitiſh grey colour, which again poſſeſſes the following diſtinct properties: It adheres to the magnet in the greateſt abundance, but not in confuſed cluſters like iron-ſtone ſimply torrefied: a manifeſt indication to become attached in the form of fibres is viſible; and the quantity taken up is equal in point of bulk to the effect produced with iron filings.

2. Iron-ſtone in this ſtate pulveriſed, when ſtrewed in the flame of a fire or candle, gives out metallic ſparks, like the combuſtion of iron-filings when ſtrewed in the ſame manner. When the flame of the blow-pipe is directed upon it, a conſiderable inflammation takes place, and the metallic particles again become oxydated.

3. In this ſtate iron-ſtones poſſeſs the property of effervеſcing violently with the ſulphuric and muriatic acids. The iron and lime are inſtantly diſſolved, without the production of heat. This is only peculiar to iron-ſtones at this period

period of de-oxygenation. In no other ſtate either raw or roaſted does iron-ſtone poſſeſs this property, unleſs highly united to lime; but remains undiſſolved till it has attracted a portion of the oxygen from the acid with which it is in contact.

From theſe confirming circumſtances I conclude, that the particles of metal exiſt in a highly diſengaged ſtate; that they are partially malleable, yet ſo much combined with oxygen as to be eaſily precipitated, in fuſion, for the production of caſt-iron, with a ſparing proportion of fuel, and a proper application of ſolvents. So far, therefore, as this experiment leads us, the practical analyſis of this ore may be thus ſtated:

In the aſſay-furnace this iron-ſtone yielded a button of ſuper-carbonated crude iron equal to - -		39·5 parts.
Water, carbonic acid, and ſulphur, loſt in ſimple diſtillation - - - - -		33·6
Oxygen taken up by the charcoal - -	9·0	
In the ſubſequent part of the operation I found that, when the iron-ſtone had aſſumed malleability, and brightened under the file, a further quantity of oxygen was taken up, equal to - - -	4·2—	13·2
Clay, lime and ſilex united in the ſtone -		13·7
		100 parts.

The earths I found to be proportioned nearly as follows: Clay 7 parts, calcareous earth 4, ſilex 2·7 = 13·7.

II. Of a calcareous iron-ſtone, reduced in the ſame manner, I operated upon - - - 1750 grs.

After being expoſed to a ſimilar diſtillation, I found it to weigh - - - 1090

Loſt in water, acid, and ſulphur, equal to 37·7 per cent. - - - - - - 660 grs.

This iron-ſtone, when torrefied, exhibited a thin ſchiſtus of of calcareous plates: its fracture alſo preſented calcareous lines running in various directions: its colour was reddiſh brown, partially fibrated, magnetic, and tenacious to the tongue.

I took of the ſame, mixed with charcoal duſt, and expoſed the veſſel to a temperature equally high with the former.	1750 grs.
The reſidue, when carefully ſeparated from the charcoal, waſhed and dried, weighed - -	922
	828 grs.
Loſt in ſimple diſtillation, as formerly ſhewn,	660
Oxygen taken up by the charcoal, equal to 9·6 parts in 100 - -	168 grs.

In this ſtate the ſtone was pulverulent, much frittered, and of a darkiſh grey colour. Its fracture exhibited a number of white ſpots like madrepore. In many places lime was diſtinctly perceived: when pulveriſed, it ſparkled in the flame, diſſolved rapidly in acids with a violent effervefcence, was leſs magnetic than the former, though poſſeſſing a great tendency to adhere in the form of fibres. From this treatment the practical analyſis of this ſtone will ſtand as follows:

In the aſſay furnace it yielded, of ſuper-carbonated crude iron, - - -		37·5 parts
Water, acid, and ſulphur loſt, as formerly ſhewn, - - -		37·7
Oxygen taken up in the firſt ſtage of de-oxygenation - - -	9·6	
Afterwards taken up in cementing the iron-ſtone to render it malleable - -	4·9	—14·5
Clay, lime and ſilex - - -		10·3
		100 parts

By diſſolution in acids, I found the earthy parts to be nearly as follows: Lime 5·2—Clay 3·1—Silex 2 = 10.3.

This

This analyſis muſt not, however, be taken as a ſtandard whereby the quantity of iron and earth is to be judged of in calcareous iron-ſtones in general. The iron-ſtones of this claſs contain much leſs iron than argillaceous or even ſiliceous iron-ſtones: 28 to 32 per cent. are products more commonly met with than 37 and upwards; the difference in point of metal being made up in lime and clay. In ſtating the quantity of oxygen diſengaged, I conceived it proper to adduce iron-ſtones, though of different claſſes, yet containing nearly the ſame weight of metal as the quantity either diſengaged or abſorbed muſt be in a direct ratio to the exiſting quantity of iron.

III. I operated with a ſiliceous iron-ſtone, weighing alſo - - - - - 1750 grs.
compoſed of ſmall pieces, and expoſed for the ſame length of time, and to the ſame degree of heat as the former claſſes: the reſidue weighed - - - - - 1249

Loſt in volatile matter by ſimple diſtillation, equal to 28·6 per cent. - - 501

In its preſent ſtate the fracture of this iron-ſtone was reddiſh brown, ſtudded with ſpiculæ of ſhining ſilex, ſlightly adheſive to the tongue, and conſiderably obedient to the magnet.

I next introduced into a crucible, ſtratified with charcoal-duſt, ſome pieces of the ſame maſs, weighing - - - 2374 grs.
and expoſed them to a degree of heat of equal intenſity with the former; after the pieces were waſhed, and carefully dried, they weighed 1343

Amount of water, acid, ſulphur, and oxygen diſſipated - - - 1031 grs.

Equal to - - - 43·4 parts in 100
Loſt in ſimple diſtillation as above 28·6

Oxygen taken up - - 14·8

This iron-ſtone was frittered, very magnetic, but diſſolved leſs rapidly in acids, and with leſs effervefcence; colour of the fracture light grey, and ſlightly ſpongy. The practical analyſis of this ſiliceous iron-ſtone will therefore ſtand thus:

Carbonated crude iron obtained in the aſſay furnace - - - - - -		36 parts.
Water, acid, and a conſiderable portion of ſulphur - - - - -		28·6
Oxygen taken up as above -	14·8	
Further, as will hereafter be ſhewn in making the iron-ſtone paſs into a ſtate of malleability - -	2·5	—17·3
Earths, viz. ſilex 9, lime 6, clay 3·1, = -		18·1
		100 parts.

In theſe experiments I wiſhed to obtain reſults which would throw light upon the de-oxygenation of iron-ſtones, with a view to apply them to practice upon an extended ſcale. I therefore uſed freſh ore, in order to preſent nearly the ſame ſurface to the action of the heat, and to be able to judge of the reſults apart from each other. In torrefaction it frequently happens that the ſtone is reduced too ſmall to enable us, by its ſubſequent treatment, to form a probable opinion of the tenacity, or otherwiſe, with which iron-ſtones hold their oxygen. The difference betwixt returning into the crucible the ſame pieces deprived of their volatile mixtures, and operating upon freſh ore, cannot be great, eſpecially when they are ſelected from fragments of the ſame maſs, directed by an intimate acquaintance and thorough knowledge of the qualities indicated by their external forms.

All iron-ſtones thus expoſed to de-oxygenation become more or leſs ſaturated with carbon; it forms a union like carbon in ſteel, and its preſence is only aſcertained when the iron-ſtone is diſſolved in an acid, by riſing to the top, and forming a fine pellicle poſſeſſing luſtre and various ſhades of of colour. I have alſo at times detected crude carbon in the centre of pieces of ore $1\frac{1}{2}$ inch diameter. To the remainder of this mixture, after the oxygen is taken up, ought to be attributed the natural tendency which moſt malleable iron made in this proceſs has of becoming red-ſhort.

The average of the reſults of the principal claſſes of iron-ſtones may ſerve for information on the products obtained, by treating thoſe of equal quantities of mixture. The analyſis here furniſhed is not that of the chemiſt, or laboratory; but, though the calculations are leſs rigorous, yet they are ſufficient for the manufacturer, and better ſuited for practical information; as they never once loſe ſight of their application and effects in the large way of manufacture, and as they have been chiefly effected by an agent, which alone, in the large way, can modify the whole, and procure reſults conſonant to the uſe and exiſtence of the metal.

From the amount of the experiments here recorded I would be apt to draw this concluſion, that, in general, iron-ſtones are variouſly combined with oxygen as to quantity: argillaceous iron-ſtone, leaſt; calcareous, more; and ſiliceous iron-ſtones, moſt of all.

In the general arrangement which I have made of iron-ſtones in this and the preceding paper, I wiſh not to be underſtood as having comprehended every variety which may exiſt; new claſſes may be brought to light, as the progreſs of diſcovery and eſtabliſhment advances. I am at preſent, however, acquainted with only one exception, which, from its ſcarcity, I have avoided claſſing along with thoſe generally uſed. My experiments alſo have hitherto been limited as to the nature, ſo that at the preſent time I am only enabled to ſtate a few, of its diſtinguiſhing properties. This iron-ſtone is found near to Clough Iron Works, in the county of Lanark. Its appearance is much like a coarſe ſchiſtous coal; its average thickneſs is about $1\frac{1}{4}$ inch; poſſeſſing a dark ſandy fracture, and by no means reſembling an ore of iron. The mixture is a union of coal and iron with

with a ſmall proportion of ſilex. Its inflammability is great, and it requires a cautious preparation for the blaſt-furnace. For this purpoſe it is built upon a thin layer of coals, in piles not exceeding 20 inches, or 2 feet: the coals are kindled in the uſual manner, and convey ignition to the incumbent ſtone. Theſe precautions are abſolutely neceſſary, otherwiſe the whole ſtone would be connected in one general maſs by fuſion.

I expoſed of this ſtone to diſtillation - -	979 grs.
in a bright red heat for 7 hours, during which time a conſiderable degree of combuſtion took place, and a black vapour was diſengaged; when cool, the reſidue weighed - - -	476
Loſt, of water, bitumen, and carbon, equal to $51\frac{3}{10}$ per cent. - - - -	503 grs.

In this ſtate, the iron-ſtone was divided into thin, blue laminæ, of a vitreous nature, and very weakly magnetic.

I next torrefied, of this ſtone in contact with charcoal-duſt, - - - - -	1163 grs.
When ſeparated, waſhed, and dried, the reſidue weighed - - - -	590
Loſs of mixtures equal to $49\frac{4}{10}$ per cent. -	573 grs.

The charcoal was in part conſumed, and part of the ſurface of the ore expoſed to contact with air, otherwiſe it is probable that the loſs in de-oxygenation would have been leſs, by the quantity of carbon contained in the ſtone, than in torrefying in the open air; where the carbon muſt infallibly be conſumed, and the loſs greater. In this ſtate of de-oxygenation this iron-ſtone poſſeſſes the uſual properties peculiar to the other varieties. At Clough it is highly eſteemed, both as to the quantity and quality of the iron it affords. It is reckoned, in a torrefied ſtate, to yield in the blaſt-furnace from 55 to 60 per cent. This is eaſily accounted for, when it is conſidered, that it loſes more than half its weight in torrefaction.

IV. *A short Account of Souffriere in the Island of St. Lucia. From* Obfervations on the Difeafes which appeared in the Army there in December 1778, &c. *By* Dr. Rollo.

HAVING in our Number for Feb. laid before our readers an account of the volcano in the ifland of St. Lucia, from the Swedifh Tranfactions, the following particulars refpecting it and the neighbourhood are now inferted, as they tend to make the defcription of that fingular fpot more complete.

" Souffriere is a fmall town fituated at the bottom of a bay towards the leeward extremity of the ifland. It is furrounded by hills covered with trees, the declivities of which, and every part capable of produce, are cultivated, and afford good fugar-cane. This place has its marfhes, but not fo extenfive, or fo much to windward as thofe about Carenage.

" The extremity of the fouth fide of Souffriere Bay runs into two fteep hills of a conical figure, which are nearly perpendicular: they are reckoned the higheft on the ifland, and are known by the name of the Sugar-Loaf Hills. From their height and ftraitnefs it is impoffible to afcend them: we were told it was once attempted by two negroes, but they never returned. They are covered with trees and fhrubs, and are the fhelter of goats, feveral of which fometimes defcend, and are fhot by the natives.

" After you pafs the hills to windward of Souffriere, a fine, clear and level country prefents itfelf. From the back of the Sugar-Loaf Hills, and all along the fea-coaft, to the diftance, we fuppofe, of from fifteen to twenty miles, this flat or level extends: it is all cultivated and divided into rich eftates, affording fugar-cane equal to any in our iflands. This beautiful fpot is interfected by many rivers of very clear water, and thefe are conducted by art to the purpofe of fugar-making. The rains in this part are lefs frequent than on any other part of the ifland; however, they have often a

 pro-

proportion more than ſufficient. The wind here blows from the ſea, or nearly ſo.

"We cannot finiſh this deſcription without taking notice of a volcano in the neighbourhood of Souffriere. You paſs over one or two ſmall hills to the ſouthward of the town, and, before any mark of the place is perceived, you are ſenſible of the ſmell of ſulphur. The firſt thing you diſcern is a rivulet of black running water, ſending forth ſteams as if nearly boiling. From the proſpect of this you ſoon open on the volcano, which appears in a hollow, ſurrounded cloſe on every ſide by hills. There are only two openings; the one we entered, and another almoſt oppoſite to it on the north ſide. In the hollow there are many pits of a black and thick boiling matter, which ſeems to work with great force. Lava is ſlowly thrown out; and in the centre of the hollow there is a large maſs of it, forming a kind of hill. This we aſcended; but were ſoon obliged to return, from the exceſſive heat. The lava is a ſulphur mixed with a calcareous earth and ſome ſaline body. We found ſmall quantities of alum in a perfect ſtate. In the opening, at the north ſide of the hollow, there is a rivulet of very good water. On ſtirring the bottom, over which this water runs, we were ſurpriſed with feeling it very hot; and on placing a tumbler filled with ſome of the water cloſe to the bottom of the rivulet, it ſoon became ſo hot as not to be touched. The liquid which runs from the pits is ſtrongly impregnated with ſulphur, and reſembles a good deal the preparation ſold in the ſhops, known by the name of *aqua ſulphurata*, or *gas ſulphuris*. Before St. Lucia was in our poſſeſſion, two or three veſſels were loaded with the crude ſulphur of this volcano, for the uſe of America."

V. *Extract of a Report, on the Means to be used for purifying the Air in the Apartments of Sick Persons, made to the Society of Medicine at Brussels.* By J. B. Van Mons.

THE principal object of the author, in this Report, is to prove that it ought not invariably to be the aim of the physician to repair the loss of a portion of the respirable air in the atmosphere which surrounds the patient; since diseases may occur, such as those of a putrid and inflammatory nature, where an augmentation of the unrespirable part may be beneficial. In such diseases, if air of the common standard be respired, the patient is furnished with such a portion of oxygen as, by increasing animal heat and accelerating circulation, must naturally increase the fever, inflammation and putrefaction, or decomposition of the blood and other humours. A lowered atmosphere, which in health is improper for respiration, must in these states prove salutary, as, by affording less oxygen to the system, it will abate inflammation, check the putrefaction, and diminish other bad symptoms, producing the good effect of what are called cooling medicines. These principles are confirmed beyond a doubt by daily experience *.

"It is," says this author, "to the salutary effect produced by diffusing through the atmosphere a new portion of unrespirable and of diminishing the respirable air that fumigations have been so long indebted for their being employed as correctors of corrupted air, while those who prescribed them often did so on a very contrary supposition.

"In general I have found the air in the apartments of sick persons to consist of abundance of carbonic acid gas, hydrogen gas, oxygen gas, and azotic gas; sometimes of a

* No facts of this kind are known in England; and from the experience of Dr. Thornton and others, it would seem, that a super-oxygenated air is highly beneficial in putrid diseases, although it be inimical to those of an inflammatory nature. Edit.

little

little ammoniacal gas, and a peculiar emanation called contagious miafm, which appears to be a particular combination of hydrogenous carbonic acid gas, holding in folution animal fluids as yet little known. Hydrogen gas almoft always holds in folution pure carbon, phofphorus, &c. from which arifes the fmell of thefe gafes, often fo difagreeable. Carbonic acid gas would form a much more confiderable part of the atmofphere which furrounds fick perfons, were not this gas continually neutralifed and rendered concrete by the ammonia, which is formed and evolved in all difeafes where animal fubftances containing azot are decompofed. It may readily be perceived into what contradiction thofe have fallen who fuppofe air to contain at the fame time carbonic and ammoniacal gas. The abfurdity of expofing in the apartments of the fick, veffels filled with quick-lime, muft alfo be obvious; the inconvenience of which, in all cafes, is to leave in a difengaged ftate, or to return to the air, the ammoniacal gas; the carbonic acid gas, which would otherwife neutralife it, being taken up by the ftronger affinity exerted upon it by the lime; and, in fome cafes, to take away an unrefpirable gas, the prefence of which would be beneficial.

"I have afcertained that in a ftate of health we form by refpiration more water, and in a ftate of difeafe more carbonic acid. The carbon feems, at a certain temperature, to exercife on the oxygen a ftronger attraction than the hydrogen can in the fame temperature. Among the principal means for purifying infected air I clafs vaporifed water, which incommodes the patient very little, and takes putrid emanations out of circulation better than the muriatic and acetous acids, or than fpirits, being a better folvent than thefe liquids. When the air is furcharged with ammonia, I would rather let loofe into it the carbonic acid gas than the acetous or any other acid. The cafe in which C. Guyton employed with fo much fuccefs the muriatic acid vapours was totally different from thofe which have been the objects of my refearches.

The fulphurous acid gas would be ufeful in fome cafes to decompofe miafmata, by giving up to them a portion of its oxygen; but it leaves behind it an oxyd of fulphur, the fmell of which is extremely offenfive: the oxygenated muriatic acid gas ought therefore to be preferred.

The gafes which in my opinion ought to be employed for augmenting the portion of unrefpirable air, are the carbonic acid gas and hydrogen gas. The firft ought to be made to pafs through water, and the fecond through oil. By thefe means you free the carbonic acid gas from that portion of the acid employed to difengage it from the carbonat ufed, which it carries along with it; and you precipitate from the hydrogen gas the carbon it holds in folution. The oil, after being ufed fome time for this purpofe, is found quite black, and converted into empyreumatic or carbonated oil.

VI. *Simple and Eafy Method of Cleaning and Whitening Prints or Engravings. By* M. Fabbroni. *From* Annali di Chimica, *by* Brugnàtelli. *Vol. XIV.*

THE methods formerly employed for cleaning engravings confifted in wafhing them in pure water, or a weak lixivium of pot-afh, or in expofing them a very long time to the dew. Aquafortis has alfo been fometimes employed. Leys, however, together with the dirt and filth, carried away part of the colour of the engraving, and aquafortis attacked the vegetable fibre of which the paper of the print was compofed.

Since the difcovery of the oxygenated muriatic acid by Scheele, and the application of its properties, by Berthollet, to the bleaching of cloth, trials have been made of it alfo for whitening prints and engravings; and Chaptal's experiments on this fubject were attended with the beft fuccefs *.

* For Chaptal's procefs fee Phil. Mag. Vol. II. p. 28.

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This procefs, however, is not fo generally followed as it ought to be, chiefly becaufe the preparation of the oxygenated muriatic acid is attended with more trouble than fome people will take, and becaufe it is fometimes difficult to procure the acid ready made. This confideration induced M. Fabbroni to make known the following procefs, which is extremely eafy, and may be put in practice by any one.

Half fill a glafs bottle with a mixture compofed of 1 part of the red oxyd of lead, or minium, and 3 parts of the muriatic acid ; and having clofed the mouth of the bottle with a glafs ftopper, put it in a cool place, not expofed to the light. A certain heat will then be produced, which is an indication that new combinations are formed. The oxyd of the lead abandons a confiderable portion of its oxygen, which remains combined with the liquor * ; the latter then acquires a beautiful gold colour, and affumes the odour of the oxygenated muriatic acid. It holds in folution a fmall portion of the lead, which does not in the leaft injure its effect †. It is neceffary that the bottle fhould be of ftrong glafs, and that the ftopper be well fecured, in order to prevent the elaftic vapour which rifes from forcing it out. When you employ the liquor thus prepared, take a large pane of glafs, and raife a kind of border of white wax around its edge, about two inches in height, and every where equal. By thefe means you form a fort of trough, into which put the prints, and pour over them a little frefh urine, or water mixed with a portion of ox-gall. At the end of three or four

* Where the oximuriat of pot-afh can be had, the procefs recommended by Mr. Cruickfhank, of Woolwich Hofpital, will be found neater than the one here propofed. If the oxygenated muriat of pot-afh be fimply added to the muriatic acid, diluted with about an equal bulk of water, the falt is flowly decompofed, and the acid converted into the oxygenated acid. About 1 drachm of the falt, if pure, is found to be fufficient for three ounces of the dilute acid. EDIT.

† If this be a fact, the portion of lead held in folution muft be fmall indeed—otherwife it fhould be partially revived in a length of time, and produce blacknefs. EDIT.

days pour off whichever of theſe liquids you have employed, and ſupply its place with warm water, which ought to be changed every three or four hours, until it come off perfectly clear. When the matter with which the prints are dirtied is of a reſinous nature, which ſometimes happens, dip them in a little alcohol: afterwards ſuffer all the moiſture to drain off, and cover the prints with the liquor of the oxygenated muriatic acid made by minium. Place on the edges of the wax another pane of glaſs, of the ſame ſize as that below, in order that you may not be too much incommoded by the ſmell of the acid; and you will then plainly ſee the yelloweſt prints reſume their original whiteneſs. One or two hours will be ſufficient to produce the deſired effect. Having then poured off the acid, waſh the prints, ſeveral times, in pure water, and dry them in the ſun.

VII. *Obſervations on the Britiſh Trade with Turkey. From* Eton's Survey of the Turkiſh Empire.

FORMERLY the trade to Turkey was of conſiderable importance to this country; but of late years it had been languiſhing, and at laſt dwindled into a ſtate of inſignificancy, when the preſent war entirely put a ſtop to all communication with the ports of the Levant.

As this trade will be again opened when a peace takes place, an inveſtigation of the cauſes of its decline, and the means to give it its ancient extenſion, may not, in the mean time, be unimportant to the government and to the merchants of this country.

The cauſes of its gradual decline are, 1ſt, The rivalſhip of other European nations; 2dly, The diminution of the conſumption of our manufactures in Turkey, by the impoveriſhed ſtate of the country; 3dly, Some branches of trade being got into other channels; and 4thly, The monopoly of the Levant Company in London.

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With respect to the rivalship of other nations, that cause will be considered when I speak of the Levant Company. As to the impoverished state of Turkey, it must affect the trade of other European nations as well as our own; if we are not, therefore, to expect to see it again in that flourishing state in which it was, when there were forty English houses of trade at Aleppo, (at present there is but one,) we may at least expect to have the same proportion of it as we then had; and if we acquire only this, our trade to the Levant will still be a national object. Some branches of trade are got into other channels; this regards principally certain imports from Turkey, and particularly of silk from Aleppo, whence formerly larger quantities of Persian silk came, which is not now brought thither, but the East India Company supply our market cheaper and more abundantly. Considerable quantities of cotton and drugs come from Holland and from Italy, which formerly came direct. This will also be accounted for in the next consideration, the monopoly of the Levant Company.

It is often necessary, and where merchants undertake to open to the country a new branch of trade, and where the expence and risk is great, it is just, to grant them exclusive privileges, or monopolies, for a certain limited time, to prevent others from reaping the harvest they had sown, and to secure their laudable industry as far as possible from risk; but when that risk exists no more, and when they have reaped their harvest over and over again, and have had a full compensation for their risk, their industry, and their expence, the country at large has a right to a participation of the trade. There may, indeed, sometimes exist circumstances of a peculiar nature, which give them a claim to a longer indulgence in their monopoly, particularly where that monopoly is no injurious, but, on the contrary, beneficial to the country in general, (and such is the case of the East India Company;) but in a trade where the merchants have no common stock, and can urge none of the above reasons in defence of their

 monopoly;

monopoly; where they cannot prove that any particular loſs would accrue to them by aboliſhing it; where it has operated as a reſtraint on the trade, confining it to narrow bounds, and giving a decided ſuperiority to their rivals of other nations, to the almoſt total excluſion of the products and manufactures of their country from that to which their privilege excluſively permits them to trade, ought in common ſenſe ſuch a monopoly to exiſt? The Levant Company is truly become the *dog in the manger*; it does not operate ſo much to the profit of the company, as to the loſs of the country.

This monopoly is of a ſingular nature: it has none of the advantages of a common ſtock, in which many individuals riſk ſmall ſums, but which in the aggregate amount to a larger capital than any one merchant or ſet of merchants poſſeſs, or would chooſe to riſk; a common ſtock to which any one may contribute, and which thereby, ſtrictly ſpeaking, ceaſes to be a monopoly: it is a privilege granted to certain perſons only to trade to Turkey, each with his own capital, and for his own particular account and riſk, without any aſſignable reaſon why they ſhould be preferred to others his majeſty's ſubjects: it has all the diſadvantages of other monopolies; it has not one of their advantages.

In ſpeaking thus freely of the company, I ſolemnly declare that I have no private motive, no rancour againſt any individual, and no inducement for writing on this ſubject but the advantage of the country. The few members of the company with whom I am acquainted I perſonally reſpect and highly eſteem: on this ſubject they muſt differ with me; they are bound by oath to ſupport the intereſts of their body.

The trade of all other nations to Turkey is free, and they have experienced the advantage of being liberated from the fetters of excluſive privileges. Let every obſtacle be removed in this country to an equally free commerce, and the ſuperior induſtry, ſkill, and riches of our manufacturers, our

traders,

traders, and our navigators, will again reftore to us our loft Turkey trade.

It may be faid, that at prefent the Levant Company is not a monopoly, as any one, by paying twenty pounds, may become a member of it. When the trade was already ruined, it was imagined that this regulation was equivalent to laying the trade open, (a proof that government have thought it neceffary to abolifh the monopoly;) but the bye-laws of the company, and the power to enforce them, were permitted to exift, and thefe fo fetter the trade to new adventurers, that few have found their account in purfuing it, and the trade ftill remains a monopoly in favour of the old houfes.

It will be neceffary to pafs in review thefe bye-laws, which have operated fo injurioufly to the trade in general; and to fhow how they have gradually effected its total ruin, and the introduction of rivals, who have gotten poffeffion of what we have loft.

By one of the bye-laws, for inftance, it was enacted, that all merchandife brought from Turkey, and imported into England, fhould be the produce of goods exported from England to Turkey. The following are the words of the bye-law:

" That upon entering goods received in England from Turkey or Egypt, every member fhall in like manner fubfcribe the following affirmation; *videlicet:*

" I affirm, by the oath I have taken to the Levant Company, that the goods above mentioned are for account of myfelf, or others free of the faid company, or of fuch as now have their licence to trade, and are beyond the feas; and that the faid goods, nor any part of them, are not, to the beft of my knowledge, the produce of gold or filver, either in coin or bullion, fent into Turkey; but that the faid goods are purchafed by merchandife, or monies arifing or to arife from the fale of merchandife fent into Turkey or Egypt, from Europe, or from the Britifh fettlements in America, on account of freemen of the Levant Company, or fuch as have their licence to trade, and of which regular entries have been made with the company, or are purchaſed by freight received in Turkey or Egypt, by ſhips navigated according to law; which freight is entirely the property of members of the company, or ſuch as have their licence to trade."

And every merchant or factor in Turkey or Egypt is required to make a ſimilar affidavit, on exporting goods from Turkey for England; and to give, on oath, an exact account of every kind of tranſaction or buſineſs, direct and indirect; ſo that all his affairs become known.

The object of this law is evidently to encourage the exportation of cloth; and when we had no rivals, it produced no bad effects; but it ſoon produced rivals, and it continued in force till they had nearly got poſſeſſion of the whole cloth trade. Such a law, indeed, was ſufficient to ruin any trade. One houſe may deal in exports, another in imports; one may combine its Italian with its Turkey trade; another may ſend veſſels for the carrying trade: but if every individual houſe be obliged to keep an exact regiſter on oath, and under a penalty of 20 per cent. called "a broke," of all its exports and imports, and to balance them exactly, how is ſuch a trade to proſper, where the profits are reduced by the rivalſhip of foreign nations? This bye-law at length, when it had produced the full effect of its ill tendency, was repealed; but the trade was not revived: ſo difficult is it to turn back commerce from channels into which it has run.

It will be aſked, then, what are the reſtraints which now lie on the trade?

The ſubjection to the control of the company; the neceſſity of making entries with it of all their tranſactions on oath, and not being able to be concerned in anywiſe with others not free of the company, or foreigners; the power in the company, for the leaſt violation of their rules, to inflict a penalty of 20 per cent.; the idea of reſtraint, and the apprehenſion of violating a ſolemn oath, have made many determine to trade with Turkey through foreign and circuitous channels, without becoming free of the company: witneſs

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the very large quantities of cottons and drugs, &c. which come from Holland and Italy, as the custom-house books prove. This was the case till our trade to Holland and the Mediterranean was stopped by the war, and in that same situation we shall be when a peace takes place.

The drugs, &c. which are imported from Italy, were carried thither from Turkey; they had already given a profit to the Italian factor in Turkey; to the importer, and to the purchaser in Italy, who cleans, assorts, repacks, and often adulterates them; to the commissioner, who purchases them for his correspondent in England; to which add charges, and interest of money for so long a disbursement, which the different people through whose hands the merchandise has gone have all calculated, as well as their profits, double freights, and loading and unloading, &c. &c.

Cottons are imported from Holland, because the company cannot import themselves enough for the consumption; and the reason why they do not is, because the old members, who are under no apprehensions of the bye-laws, find other articles enow to employ their whole capital, and beyond that the trade cannot increase. This is the reason, as will be seen hereafter more fully, why the trade in exports as well as imports is confined within such narrow bounds.

The British merchants in Italy and other foreign countries, not being members of the company, (and to become free of the company they must come to England,) cannot trade with British houses in Turkey; and these, if they will trade to Italy, must trade with foreigners: thus all combinations of the trades are prevented. English vessels in the Mediterranean might often make a voyage to Turkey, instead of lying in an Italian port, and return time enough to take in their cargoes for England.

The great preference given to British vessels in the Mediterranean would assure them an employment whenever they want freights. This carrying or caravan trade is so extensive, that,

that, beſides the French, the little ſtate of Raguſa has no leſs than 400 veſſels in it.

Were the maſters of ſhips, their owners, and the Engliſh merchants in Italy and Turkey, under no reſtraint in regard to the Levant Company, people would riſk more readily the ſending their veſſels to the Mediterranean to get employment in this carrying buſineſs, and, their ſpeculation in trade being free, they would find means to employ their veſſels in the intervals of their being without freights; the maſters, owners, and correſpondents might combine their own ſpeculations in merchandiſe with their carrying buſineſs, and thus keep them conſtantly employed. It is the want of theſe reſources to our ſhips, that prevents Engliſh owners from ſending their ſhips into the Mediterranean to ſeek freights, and prevents the few which do go thither from profiting ſo much by it as thoſe of other nations, whoſe houſes of trade are nearer, and whoſe trade is under no reſtrictions.

Had the Turkey trade in England never been a monopoly, the French would never have got poſſeſſion of almoſt all the cloth trade; and the laying it open will be the only means of our coming in again for any conſiderable ſhare in it. There is a greater demand in Turkey for the light Languedoc cloths, than for any other ſort. The Turks clothe their ſervants twice a year; and the French cloth, made into looſe garments, (which laſt much longer than the tight European dreſs,) is ſtrong enough for their purpoſe, and its cheapneſs cauſes it to be preferred; poorer people, who form the great body of conſumers, buy it alſo for œconomical reaſons. Engliſh broad cloth, called mahoot, (of a light quality, made purpoſely for the Turkey market,) is only worn by thoſe in eaſier circumſtances. Conſiderable quantities of cloth have alſo of late years come to Turkey from Germany.

It is the opinion of many people well acquainted with theſe matters, that the Engliſh manufacturers might make the ſame ſort of cloth as the Languedoc, and as cheap as the French;

French; but, as long as the Levant Company exifts, who is to undertake it? Were the trade laid entirely open, it is probable that all kinds of Englifh manufacturers would fend people (called riders) to Turkey to feek for commiffions, as they do to all parts of Europe. This practice, though not very agreeable to Englifh merchants, (which however may not be the cafe in Turkey, as they may find the mediation of merchants neceffary,) would greatly increafe the vent of Englifh commodities, and thefe induftrious people might poffibly be the means of our regaining the cloth trade.

The few merchants who are in the true fecret of the Levant trade, can employ in it their whole capital advantageoufly, and therefore do not feek for new branches, or how to recover old ones which are loft.—This is the great fecret.

The French do not get their wool cheaper than we do; the price of labour may be lefs; but will not fuperior fkill and induftry, with larger capitals, compenfate this fingle circumftance againft us? Experience in other articles fhews it, as in the manufactures of Manchefter, Sheffield, and Birmingham.

It is very worthy of attention, that the French cannot make fo cheap as we can the fame kinds of cloth, which our people bring to the Turkey market; it is not that they cannot make them fo fine, for they make in France much finer cloth than that kind of broad cloth made in England purpofely for the Turkey market. There is alfo a coarfe ftrong cloth brought to Turkey from England, called *londras:* thefe the French cannot make fo cheap neither; nor are their fhalloons fo cheap. In fhort, there is no fort of woollen ftuff made in the two countries, of the fame quality, which the Englifh do not fell cheaper than the French. The fact feems to be, that the French invented a kind of cloth more proper for the general confumption of Turkey than that which the Englifh had brought thither; and the Englifh never attempted to follow their example, but continued car-

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rying to the market a ſort of cloth, which at laſt got almoſt out of uſe. Whenever the Engliſh ſhall have made and brought to Turkey the ſame kind of cloth as the French, and cannot afford it ſo cheap, then with certainty we may conclude that the French have an advantage over us; but till then it ought to be doubted, and certainly it merits the trial; but a fair trial never can be made till the Levant trade is entirely free.

But even ſuppoſing that we cannot regain the cloth trade, there are very many other objects worth attending to, and which may be of great national advantage.

The Mancheſter ſtuffs would find a great vent in all parts of Turkey. The manufactories of Aleppo and Damaſcus are almoſt ruined; and if the Mancheſter people were to imitate the Turkiſh patterns of their ſtuffs, they could certainly afford them cheaper. Imitations of the Surat and Bengal goods of ſilk and cotton, which are enormouſly dear, would find alſo a ready ſale in Turkey; and cotton velvets, velverets, &c. Birmingham and Sheffield wares would be articles of importance. The Turks, both in Europe and Aſia, have a great partiality for all theſe kinds of Engliſh manufactures, and in general the epithet Engliſh is ſynonimous with excellent.

Theſe articles at preſent are not attended to; but the maſters of ſhips, who bring out their little ventures to Turkey in a contraband manner, in theſe kind of things, make great profits; they can, however, bring only ſmall quantities, leſt the Levant Company ſhould take umbrage at it. A few of theſe goods alſo find their way to Turkey from Italy, but greatly enhanced in their price from the many hands they go through, and therefore this channel does not afford a great vent for them. Linen may likewiſe be an article of exportation for Turkey. The Turks wear linen of a hard twiſted thread, very open and unbleached, which comes moſtly from Egypt, and is exceedingly dear, but is the moſt pleaſant kind to wear in hot weather. No European nation

has

has yet undertaken to imitate it; but it is probable it might be made in Ireland infinitely cheaper than in Egypt: if this was the cafe, it would be of great importance. The German linens begin to be fold in confiderable quantities in Turkey; but they never will fupply the place of the Egyptian, on account of their quality. Vaft quantities of the above mentioned articles come from Venice and Germany, where they are dearer, and of worfe quality, than thofe manufactured in England.

Were I to enter into an enumeration of all the Englifh manufactures that could be fold in Turkey, and particularly in the interior parts of Afia, and point out the different ports to which they might be fent, the detail would be too long for a general reprefentation; but collectively it muft be very obvious to every perfon acquainted but generally with the trade of Turkey, that our exportations to that country muft become of great importance in a few years, were the monopoly removed, and the agents of the manufacturers fent to travel through the country, and get certain information of the ftate of its trade and manufactories.

Salt fifh, could the Newfoundland fhips, &c. go directly to Turkey as they go to Italy, would be a very important branch.

The Eaft India Company could fupply the Turkey market with muflins much cheaper than they are brought by the way of Baffora, of Gidda, and Suez, which trade is entirely in the hands of their fervants: the trial has been fuccefsfully made; but the members of the Levant Company have other articles enow in which to inveft their whole capitals. Other nations now bring large quantities of muflins to Turkey. Britifh muflins (*i. e.* manufactured in Britain) alfo fell to confiderable profit.

Let all this be mere fuppofition, is not the object of importance enough to give it a fair trial? and does not common fenfe fay, that a trade freed from obftacles muft flourifh more than when clogged with the moft unfupportable fhackles, or

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with any ſhackles at all? May it not be aſked, what juſt right have the members of the Levant Company to lay reſtraints on this trade by their bye-laws? I have heard this ſubject diſcuſſed in Turkey, where people certainly underſtand the trade of the country better than in England, and I never heard one plauſible reaſon alleged in favour of the company. Sophiſtical arguments may be produced in London, which may appear plauſible to thoſe who are not informed of the real ſtate of matters in Turkey.

To ſhow what little efforts have been made by the company to extend the trade, and how little they deviate from the footſteps of their forefathers, I will cite two ſtriking inſtances:

Mr. John Humphrys, of Conſtantinople, was the firſt, who, a few years ago, imagined that Engliſh ſhalloons might be ſold in Conſtantinople, and they ſoon became a very important article for exportation to Turkey. The French have not been able to make them ſo cheap.

Mr. Peter Took, of Conſtantinople, only about twenty years ago, diſcovered that he might buy raw ſilk from the firſt hands at Bruſa, (the hills behind this city are viſible from our merchants houſes in Pera,) and thus make his returns direct to England. Before that period, from the firſt exiſtence of the company, the merchants of Conſtantinople had always ſent their money to Smyrna to be inveſted in ſilk, which the Turks and Jews of Smyrna bought at Bruſa.

There is a great demand in Turkey for Staffordſhire earthen-ware, which would become a very important article of commerce.

Perhaps the greateſt importation of Britiſh articles into Turkey would be by foreigners, or natives of the Turkiſh provinces, as is the caſe in many branches of our commerce, where ſuch reſtraints on foreigners do not exiſt; for inſtance, every one knows that not one-tenth part of our exports to Ruſſia are on account of the Ruſſia Company in London, or of the Britiſh Factory in Ruſſia. Theſe articles are ſent to

Ruſſia

Russia for account of foreigners settled in Russia, or Russians, and some part for account of our manufacturers. With respect to Germany this is still more the case.

The Levant Company exact a duty on all merchandise exported to and imported from Turkey, besides a consulage in the ports of Turkey on all the exports and imports in British vessels. This consulage is a very heavy burthen on our trade, and particularly when it is considered that some other nations pay none. The following are the words of the company's bye-law:

" At a general court, &c. the following orders were established as proper and expedient for the support of the company's affairs, and for the government of the trade; and they were confirmed at a general court held 3d of March 1775.

" It was resolved and ordered, That all goods exported from Turkey or Egypt for Great Britain shall pay three consulages and one-half, or seven in the hundred, according to the rates of the company's tarif, in such species of the grand seignior's coin as his officers receive for customs; which consulage shall be paid, one-half in thirty days, and the other half in sixty days after the departure of the ship, &c.; and the company's treasurers are not to take any notes or obligations for the payments of consulages, but they are to insist upon being paid in money when it is due.

" That all goods imported, &c. into Great Britain, shall pay one imposition according to the company's rates, &c. except cotton and emery stones, &c.

" That all goods imported into Turkey or Egypt, from Leghorn, or any other port or ports of Christendom, by British subjects or British ships, for account of foreigners, shall pay a consulage of two in the hundred, &c.

" That all goods exported from Constantinople, Smyrna, and Aleppo, to Leghorn, or any other foreign port or ports of Christendom, by British subjects, on foreign ships, on account of Britiſh ſubjects, ſhall pay a conſulage of one in the hundred, &c.

"That all goods imported into Turkey or Egypt, by ſtrangers, upon Britiſh ſhips, from any foreign port, &c. ſhall pay two in the hundred, &c. and in like manner exported, two in the hundred, &c." and ſeveral other regulations for the paying of conſulage, of leſſer importance, which I omit for brevity.

"April 29th, 1785. It is reſolved and ordered, &c.

"That all goods, excepting raw ſilk, mohair yarn, and drugs, exported from Turkey and Egypt, in the time of the plague, to Malta, Ancona, Venice, Meſſina, Leghorn, Genoa, or Marſeilles, for the purpoſe of performing quarantine, and which are to be re-ſhipped on the ſame ſhip for Great Britain or Ireland, ſhall pay a conſulage of two in the hundred only."

Beſides this revenue, the company have for many years received an aſſiſtance from government of five thouſand pounds a year. All theſe ſums are expended for paying a part of the ſalary of the ambaſſadors at Conſtantinople, the conſuls at the ſeveral ports in Turkey, the chancellors and drogomans (or interpreters), and for defraying the expences attending viſits from the ambaſſador to the porte, and of the conſuls to paſhas, beſides extraordinary preſents made at the firſt audience of a new ambaſſador and of a conſul; for paying avanias (or money extorted by falſe accuſations), and public entries of conſuls, which were formerly very coſtly; and finally, for the expences of the company and its officers at home.

Were our trade put on the ſame footing as the Ruſſian, the five thouſand pounds government now pays, would perhaps more than ſuffice for all the expences which then would be neceſſary; and that our trade could be put on the ſame footing, I ſuppoſe nobody will deny. The Ruſſian trade to Turkey is free to every one; there is no tax on it, either

under

under the appellation of conſulſhip or otherwiſe; no fee is taken at any ambaſſador's, conſul's, or chancellor's office, for documents neceſſary for the diſpatch of trade; no preſents are made by conſuls to paſhas or other officers; no avania is ſubmitted to.

A conſul at Smyrna only is neceſſary. Vice-conſuls in the other ports would anſwer every purpoſe for the protection of trade; and there would be found merchants enow, who would be glad of the office without pay, for the honour of it, which in Turkey is conſiderable. There is at this day no neceſſity for conſuls living in ſuch great ſtate as they did a few years ago. The foreign miniſters at Conſtantinople have very conſiderably retrenched their expences.

The power of an ambaſſador and of a conſul in Turkey is very great; it extends even to life and death. By one of the articles of the capitulations (or treaty with the porte) it is ſtipulated, that in all criminal caſes wherein ſubjects of the porte are not concerned, ambaſſadors or conſuls ſhall puniſh the criminal according to the laws of their country. In the Dutch capitulations this is expreſſed ſtill ſtronger. As crimes committed in a ſtate are crimes immediately againſt that ſtate, the cognizance of them belongs to it alone. The ſultan delegates his power to the ambaſſadors and conſuls; and if in puniſhing the criminal they exceed the rule preſcribed by the laws of their own country, they are only anſwerable for their conduct to the ſultan; but the ſultan takes no cognizance of it, therefore they are without control, and their power is deſpotic. It is indeed true, that they generally ſend ſuch offenders home to their country; there have, however, with other nations, been examples where an European has killed a ſubject of the porte, and juſtice being demanded the ambaſſador or conſul has put the criminal to death. Should it happen that an Engliſhman killed a Turk, it would certainly be better that the ambaſſador or conſul ſhould cauſe him to be hanged by his own people, than that he ſhould deliver him up to the Turks, for juſtice being demanded, there is no other alternative; if he efcaped, the confequence might be a general maffacre; we have lately had an example at Smyrna exactly of this nature, which coft the lives of many hundreds, and caufed the European quarter to be reduced to afhes. There is no poffibility of fending the criminal home if the populace demand juftice.

The company have given alfo another power to the ambaffadors and confuls over merchants, which free traders may not approve of. Their bye-law is: "If any factor or factors fhall have any dealings with any perfon battulated by the lord ambaffador, or the conful of any of the fcales (ports, Scala Italian) in Turkey, with the advice of the refpective factories, fuch factor or factors fhall pay a fine for every offence to the amount of three confulages upon the value of the tranfaction by or with fuch battulated perfon, without appeal, &c." Battulation with them fignifies interdiction of all commerce with the perfon battulated. The intention was to prevent the factors or merchants having dealings with litigious perfons of the country; but this power has been abufed.

The ambaffador formerly had a confiderable revenue from protections granted to fubjects of the porte, under the title of Baratli, or honorary drogomans; but thefe protections having been totally difregarded by the prefent fultan, who without any ceremony has beheaded feveral perfons poffeffed of them, both that income and that fource of conftant litigation with the porte are partly done away. It were to be wifhed that this privilege was wholly abolifhed. The French feveral times propofed giving it up, and at a time when it was refpected, and lucrative to their ambaffadors.

The French alfo, on the reprefentation of their ambaffador, M. de St. Priefte, laid the Levant trade open; the confequence was, that immenfe quantities of French goods were carried to Turkey by fubjects of the porte; but the company at Marfeilles found means to get their exclufive privilege renewed; they had fuffered, but the country had gained. At prefent present every one has liberty to trade; and since our fleet has left the Mediterranean, their commerce is revived, and, except the trade to Great Britain be equally free when a peace takes place, we shall have little chance of being able to rival them: but we must not wait till that period arrives to lay our trade open; it must be done immediately.

As all communication with the Levant by sea is cut off, there remains no resource to our merchants, but to carry on their trade through Russia; and though this be a circuitous way, it is not by far so expensive as might be imagined. The freights to the Baltic are very low, as half the ships go out empty. The carriage from Riga to Cherson, or Niccolai on the Bog, is mostly by water, and the land carriage in Russia is not one fourth of the price it is in Germany. The expence on cloth would be trifling, and on cheap and bulky goods even would not be equal to the enormous price of insurance paid for armed ships, which run the voyage at present, and which is not equal to the risk; it is indeed so great, that government should, perhaps, interfere. At Cherson there are good vessels to be found, which in three days may carry the goods to Constantinople at a reasonable freight.

But in order to open such a communication, liberty must be obtained of the emperor of Russia to send merchandize in *transito* (without paying duty) across Russia; and there is no doubt but that sovereign, who has studied Adam Smith's book on the Wealth of Nations, and who is perfectly acquainted with the principles of commerce and navigation, would see the very great advantage which would accrue to Russia by such a trade, both on account of the sums which would remain in the country for expences of carriage, the employment of a number of people, and also the encouragement it would be to the Russian navigation in the Black Sea; but he never would *grant* such a privilege to a part of the British nation exclusively, and shut out from it the Russia merchants, who carry on a branch of commerce so advan-

 tageous

tageous to his empire, nor exclude his own subjects from it. Before this can be done, the Turkey Company must be abolished.

At present a few goods, I am informed, have been sent to Hamburgh, thence to Vienna, and down the Danube, where they are shipped for Constantinople. The freight to Hamburgh is dearer than it is to Riga; the charges across Germany ten times as much as across Russia. At the mouth of the Danube there are only bad Turkish or Greek vessels to be freighted, on which no regular insurance can be made. At Cherson there are some hundreds of vessels, among which many equal those to be found in the ports of other seas, and a reasonable insurance may be made on them by safe underwriters; but the route through Germany does not necessitate an abolition of the Levant Company.

VIII. *Observations on Naples Yellow, and the different Methods of preparing it. By Professor* BECKMANN.

NAPLES yellow, which is also called Neapolitan earth, in Italian *Giallolino*, and in French *Jaune de Naples*, has the appearance of an earth, is of a pale orange-yellow colour, ponderous, granulated, exceedingly friable, does not effloresce, nor become moist when exposed to the air, but when applied to the tongue seems to adhere to it. When reduced to a fine powder, it remains for some time suspended in water, but soon deposits itself at the bottom in the form of a slime. When boiled with water, the water, at least sometimes, is observed to have a somewhat saline taste. It does not effervesce with acids, but is in part dissolved by aqua-regia (*nitro-muriatic acid*). In the fire it emits no sulphureous vapour, is difficult to be fused, and by that operation undergoes no material change, only that its colour becomes somewhat redder. When fused with colourless glass, it gives it a milk-

milk-white colour, a ſure proof that it contains no iron; and, with inflammable ſubſtances, there is obtained from it a regulus which has the appearance of a mixture of lead and antimony.

This article is brought from Naples for the moſt part in the form of an earthy cruſt about three or four lines in thickneſs, and it ſometimes retains the form of the veſſel in which it has hardened. It can be procured alſo as a fine powder, as the colourmen keep it ſometimes ready pounded for uſe.

How long this colour has been an article of trade I will not venture to determine. As far as I know, Pomet is the firſt druggiſt who mentions it; but he tells us that it was exceedingly ſcarce. Kunckel, who has carefully enumerated all the ſubſtances proper for colouring glaſs, and for glazing earthen-ware, does not, as far as I have obſerved, take any notice of Naples yellow; but if names alone can afford any proof of antiquity, I would aſſert that this colour was known in Italy at any rate, about the end of the ſixteenth century; for Ferrante Imperato*, whoſe book was firſt printed in the year 1599, ſays that "there are two kinds of *giallolino*, one of which is produced from white lead by the firſt alteration." This paſſage ſeems to allude to the real Naples yellow; but perhaps he only meant the yellow calx (*oxyd*) of lead, or the ſo called maſſikot. Reſpecting the other kind, he gives no

* *Hiſtoria naturale.* Venetia, 1672. fol. p. 107: Il giallolino si fa di ceruſſa nella prima alteratione; imita nel colore il fior di gineſtra. Evvi un' altro giallolino, di cui tratteremo tra li ſmalti e l'impetente. Il minio moderno, o ſandice de antichi, si fa dell' iſteſſa ceruſſa, e giallolino paſſato in maggior roſſeza par la maggior cottura. In the Latin tranſlation printed at Cologne 1695, 4to, this paſſage can ſcarcely be known to be the ſame. *Lib.* iv. *cap.* 42, *p.* 132: Flavum e ceruſſa in prima alteratione efficitur, florem geniſtæ colore imitatur. Eſt et aliud flavi coloris genus, quo de inter encauſta atque dealbationes tractaturi ſumus. Minium modernum, vel antiquorum ſandyx, ex eadem ſit ceruſſa, et flavo acriori coctione in majorem rubidinem tranſmigrante. I ſuſpect that the term *giallolino* was uſed earlier than the pigment to which that name has been excluſively applied.

 expla-

explanation. But, however this may be, it is certain that no writer ever yet knew properly what the nature of this paint really is. Moſt of them have conſidered it as originating from fire, and as a volcanic production of Mount Veſuvius or Mount Ætna *; others have pronounced it to be a natural ochre †. Guettard thought it rather a kind of bole ‡; but Pott approached neareſt the truth, by aſſerting it to be an artificial preparation §. Fougeroux is entitled to the merit of having proved this, and of having ſhewn the poſſibility of preparing it. According to his experiments, Naples yellow will be obtained, if you boil for ſeven or eight hours, firſt over a ſlow and then over a ſtrong fire, a mixture finely pulveriſed of twelve parts of pure white lead, one part of alum, one part of ſal ammoniac, and three parts of diaphoretic antimony ‖. (*white oxyd of antimony by nitre*). But before Fougeroux, who may have obtained an account of the proceſs during his Travels through Italy, a more certain proceſs was publiſhed in the year 1758, by Giambattiſta Paſſeri, in his intereſting work on the painting of earthenware ¶. The articles to be employed, according to this author, are, " one pound of antimony, a pound and a half of lead, one ounce of *allume di feccia*, and the ſame quantity

* Among theſe are Pomet, two writers in the firſt edition of the *Encyclopedie*, Montamy in *Abhandlung von den Farben zum Porzellan*, Leipzig, 1767, 8vo, p. 266, and the editor of *Dictionnaire portatif de peinture, ſculpture et gravure*, 1757, p. 363.

† For example, Hill in his *Hiſtory of Foſſils*, vol. i. p. 55, 66. Gadd alſo in *Inledning til Sten-Rikets Kænning*. Abo, 1787, 8vo, p. 49, mentions Naples yellow among the calcareous earths mixed with metallic calces.

‡ In *Memoire ſur les ocres*, to be found in the Memoirs of the Academy of Sciences for the year 1762.

§ Lithogeognoſie, II. p. 15.

‖ In the Memoirs of the Academy of Sciences for the year 1766. p. 303.

¶ This paper may be found in *Nuova raccolta d'opuſcoli ſcientifici*. t. iv. 1758. p. 103. Il giallolino, o color d'oro, ſi fa con una libra di antimonio, una e mezza di piombo, ed un'oncia d'allume di feccia, ed un'altra di ſal commune.

of common ſalt." I am inclined to think that this receipt was not unknown to Fougeroux, and that he conſidered *allume di feccia* to be alum. Profeſſor Leonhardi, a man of very ſound learning, has tranſlated this expreſſion by the word alum. I will, however, freely confeſs, that I conſider *allume di feccia* not to mean alum, but ſalt of tartar, or potaſh *. Paſſeri ſays that the proportions may be varied different ways; and he gives ſix other receipts, in which he does not mention *allume di feccia*, but only *feccia* †; and this word certainly means *weinhefen* or wineſtone (*tartar*). Profeſſor Leonhardi himſelf ſeems to confirm this opinion, by ſaying, that Vairo, profeſſor of chemiſtry at Naples, has tranſlated "the aſhes of wine lees" (*cineres infectorii*) by the words *allume di feccia* ‡.

After

* In the 2nd edition of Macquer's *Chemical Dictionary*, vol. iv. p. 133.

† *Page* 103. Si avverte, che diverſificando le doſi, ſi diverſifica puranco la riuſcita del colore ond' è che alcune ſcuole, o fabbriche hanno avuto colori molto differenti dagli altri, anzi io oſſervo, che nelle antiche Majoliche ogni pezzo ha tinte differenti, perchè ogni maeſtro preparava i colori a ſuo modo, ed eccone alcune differenti doſi. Then follow ſix different receipts, as above mentioned :—1. Piombo libre ſei, antimonio libre quattro, feccia libra una. 2. Piombo libre tre, antimonio libre due, feccia libra una, ſale once ſei. 3. Piombo libre cinque, antimonio libre quattro, feccia once ſei. 5. Piombo libra una e mezza, antimonio libra una, feccia libra una, ſale libra una. 6. Piombo libre tre e mezza, antimonio libre due, feccia libra una.

For the ſake of the Engliſh reader we ſhall here give a tranſlation of the above ſix receipts, without pretending to explain the word *feccia*, as we confeſs we cannot throw more light upon it than Prof. Beckmann has done.—1. Six pounds of lead, four pounds of antimony, and one pound of *feccia*. 2. Three pounds of lead, two pounds of antimony, one pound of *feccia*, and ſix ounces of ſalt. 3. Five pounds of lead, four pounds of antimony, and ſix ounces of *feccia*. 4. Four pounds of lead, two pounds of antimony, and ſix ounces of *feccia*. 5. One pound and a half of lead, one pound of antimony, one pound of *feccia*, and one pound of ſalt. 6. Three pounds and a half of lead, two pounds of antimony, and one pound of *feccia*.

‡ In the firſt part, page 245. One great advantage of the new edition by Profeſſor Leonhardi is, without doubt, the addition of the foreign terms

of

After Fougeroux's paper was printed, De la Lande published a receipt which he had received from the well-known prince San Severo, and in which lead and antimony only are employed; but no mention is made either of alum, tartar, or any other salt *.

The fixity of this pigment, a property in which lead ochres, when used alone, are deficient, is ascribed by Fougeroux to the antimony and alum. The latter, perhaps, may not be necessary, but the addition of the former is indispensible. It is well known that the glass of antimony has a hyacinth colour, and that with red lead and flint it produces glass of a gold colour †.

Artists generally complain that this pigment often fails in its application, because they cannot always procure it of an equal quality. This difference arises in all probability from

of art. As dictionaries, and particularly those of the Italian language, are in general deficient in regard to scientific expressions, it would be doing a great service to the public if some man of learning would collect and explain all those which relate to chemistry and mineralogy. At any rate translators ought to follow the good example set them by M. Leonhardi.

* I shall here give the whole receipt as it stands in the last part of the newest edition of *Voyage en Italie*, par De la Lande. Paris, 1786. 9 vol. 12mo, p. 504: Take lead well calcined and sifted, with a third part of its weight of antimony pounded and sifted also. Mix these substances well together, and sift them again through a piece of silk. Then take large flat earthen dishes, not varnished, cover them with white paper, and spread out the powder upon them to the depth of about two inches. Place these dishes in a potter's furnace, but only at the top, that they may not be exposed to too violent a heat. The reverberation of the flame will be sufficient. The dishes may be taken out at the same time as the earthen-ware, and the substance will then be found hard, and of a yellow colour. It is then pounded on a piece of marble with water, and afterwards dried for use. This is what is called Naples yellow.

† To this subject belong the experiments of Lewis, who, though he carefully examined all those substances which seemed proper for colouring glass, makes, however, no mention of Naples yellow. See his *Philosophical Commerce of the Arts*.

 the

the ſame proportions of the two metals, and the tartar not being always employed, as Paſſeri has ſaid; but the inconvenience might eaſily be prevented, if the workmen who prepare Naples yellow would work according to a ſample, as is the caſe in regard to ſmalt; and if the different qualities were in the like manner marked by numbers or characters. Fougeroux was informed, from Naples, that there was an old man ſtill living there who prepared this yellow, but that he kept his art ſuch a profound ſecret that it was apprehended it would die with him. Nothing more of it was known than that he expoſed the metals which he employed to the heat of a potter's furnace for twenty-four hours.

Thoſe who attempt to prepare this colour in Germany will not certainly ſet the ſame value on the Italian receipt, and that given by Fougeroux; for the diaphoretic antimony, as well as white lead, are too dear—and ſal ammoniac, which is not cheap, is loſt in the proceſs. On the other hand, ſome advantage might be gained, if, according to the Italian method, both the metals, with a ſmall addition of an alkaline ſalt, were reduced to the ſtate of oxyds in an earthen-ware furnace. But our enamel painters prepare a yellow glazing not very different from the real Naples yellow, and for which I find a receipt in a new work*, the author of which ſeems to be a man of experience, but not of learning. According to this preſcription, one pound of antimony, ſix ounces of red lead, and two ounces of white ſand, are to be fuſed together. The produce, which appears quite black, is to be pounded, and then fuſed again; and this proceſs is to be repeated till the whole maſs becomes thoroughly yellow. Half a pound of this maſs is to be mixed with two ounces of red lead, and afterwards fuſed; and by this tedious proceſs an orange-yellow pigment will be obtained, which, however, might be obtained with more eaſe and certainty by the method pointed out above.

* Vollig entdecktes geheimniſs der kunſte fayence, Engliſches ſteingut, und porzellan zu machen. Leipzig, 1793, 8vo, p. 54.

All

All artists who speak of the use of Naples yellow, give cautions against applying iron to it, as the colour by these means becomes greenish, or at least dirty. For this reason, it must be pounded on a stone, and scraped together with an ivory spatula. It is employed chiefly in oil painting, because the colour is softer, brighter, and richer than that of ochre, yellow lead, or orpiment, and because it far exceeds these pigments in durability. It is employed in particular when the yellow ought to have the appearance of gold, and in this respect it may be prepared with gum water and used as a water colour. A still greater advantage of it is, that it is proper for enamel painting, and on that account may be employed on porcelain or earthen ware *. In the last place I would recommend to artists to examine whether the oxyd prepared from wolfram, by boiling in the muriatic acid, which has a beautiful yellow colour, might not be used in the same manner as Naples yellow †.

IX. *Comparison between the Human Race and that of Swine.* *By* I.F. Blumenbach. *From* Magazin für das Neueste aus der Physik. *Vol. VI.*

SOME late writers on natural history seem doubtful whether the numerous distinct races of men ought to be considered as mere varieties, which have arisen from degeneration, or as so many species altogether different. The cause of this seems chiefly to be, that they took too narrow a view in their researches; selected, perhaps, two races the most different from each other possible, and, overlooking the intermediate races that formed the connecting links between them, compared these two together; or, they fixed their

* In the Memoirs of the Academy of Sciences for 1767 Fougeroux has proved that the giallolino prepared by him produced on porcelain a much more beautiful colour than the Naples yellow sold in the shops.

† Gmelin's Technische Chemie, p 229.

attention

attention too much on man, without examining other fpecies of animals, and comparing their varieties and degeneration with thofe of the human fpecies. The firft fault is, when one, for example, places together a Senegal negro and an European Adonis, and at the fame time forgets that there is not one of the bodily differences of thefe two beings, whether hair, colour, features, &c. which does not gradually run into the fame thing of the other, by fuch a variety of fhades that no phyfiologift or naturalift is able to eftablifh a certain boundary between thefe gradations, and confequently between the extremes themfelves.

The fecond fault is, when people reafon as if man were the only organifed being in nature, and confider the varieties in his fpecies to be ftrange and problematical, without reflecting that all thefe varieties are not more ftriking or more uncommon than thofe with which fo many thoufands of other fpecies of organifed beings degenerate, as it were, before our eyes.

As my obfervations refpecting the bodily conformation and mental capacity of the negroes * may ferve to warn mankind againft the firft error, and at the fame time to refute it, I fhall here offer a few remarks to refute the falfe conclufion which might be formed from a carelefs comparifon of the degenerations among the human race with the varieties among other animals, and for that purpofe fhall draw a comparifon between the human race and that of fwine †.

More reafons than one have induced me to make choice of fwine for this comparifon; but in particular, becaufe they have a great fimilarity, in many refpects, to man: not, however, in the form of their entrails, as people formerly believed, and therefore ftudied the anatomy of the human

* See Phil. Mag. vol. iii. p. 141.

† See, for example, *Anatomia Porci* of the old Arabian Cophon in the beginning, where he fays: Et cum bruta animalia quædam, ut fimia, in exterioribus nobis inveniantur fimilia, interiorum partium nulla inveniuntur adeo fimilia ut porci.

body

body purposely in swine; so that even, in the last century, a celebrated dispute, which arose between the physicians of Heidelberg and those of Durlach, respecting the position of the heart in man, was determined in consequence of orders from government, by inspecting a sow, to the great triumph of the party who really were in the wrong. Nor is it because in the time of Galen, according to repeated assertions, human flesh was said to have a taste perfectly similar to that of swine *; nor because the fat †, and the tanned hides of both, are very like to each other; but because both, in regard to the economy of their bodily structure, taken on the whole, shew unexpectedly, on the first view, as well as on closer examination, a very striking similitude.

Both, for example, are domestic animals; both *omnivora*; both are dispersed throughout all the four quarters of the world; and both consequently are exposed, in numerous ways, to the principal causes of degeneration arising from climate, mode of life, nourishment, &c.; both, for the same reason, are subject to many diseases, and, what is particularly worthy of remark, to diseases rarely found among other animals than men and swine, such as the stone in the bladder ‡; or to diseases exclusively peculiar to these two, such as the worms, found in measled swine §.

Another

* Galen says, in the tenth book of his work on the Power of Simple Medicines, that tavern-keepers and cooks often served up human flesh instead of swine's flesh to their guests, without their perceiving it. He himself was told by persons worthy of credit, that they had ate of such food in a public inn with the best appetite, not knowing what it was till they at length found half a finger, when they became terribly alarmed for fear of the murderous host, who was, however, soon after caught in the fact and punished.

† See *Schwenkfeld Theriotroph. Silesiæ*, p. 127.

‡ Among the wild swine, particularly in Russian Tartary. A pretty large stone of that kind, forming a part of Baron Asch's present, is preserved in the Academical Museum of Gottingen. Domestic swine, however, are in many places subject to this malady. See *Schwenkfeld Theriotroph. Silesiæ*, ut supra.

§ I was guilty of an error when I said, in the third edition of my

Manual

Another reafon, however, why I have made choice of fwine for the prefent comparifon is, becaufe the degeneration and defcent from the original race are far more certain in thefe two animals, and can be better traced than in the varieties of other domeftic animals. For no naturalift, I believe, has carried his fcepticifm fo far as to doubt the defcent of the domeftic fwine from the wild boar; which is fo much the more evident, as it is well known that wild pigs, when caught, may be eafily rendered as tame and familiar as domeftic fwine *: and the contrary alfo is the cafe; for if the latter by any accident get into the woods, they as readily become wild again, fo that there are inftances of fuch animals being fhot for wild fwine; and it has not been till they were opened and found caftrated, that people were led to a difcovery of their origin, and how and at what time they ran away †. It is well afcertained, that, before the difcovery of America by the Spaniards, fwine were unknown in that quarter of the world, and that they were afterwards carried thither from Europe. All the varieties, therefore, through

Manual of Nat. Hiftory, p. 464, that Goze was the firft who placed the animal nature of the meafles in fwine beyond all doubt. I now find that in the laft century Malpighi gave an accurate defcription of the difeafe, accompanied alfo with a figure of the worms. See his *Opera Pofthuma*, London 1697, fol. p. 84. "In fuibus verminofis, qui vulgariter *lazaroli* dicuntur, multiplices ftabulantur vermes, unde horum animalium carnes publico edicto prohibentur. Occurrunt autem copiofi intra fibras mufculofas natium; obvia namque oblonga vefica quafi folliculus diaphano humore refertus, in quo natat globofum corpus candidum, quod difrupto folliculo leviter compreffum eructat vermem, qui foras exeritur, et videtur emulari cornua emiffilia cochlearum, ejus enim annuli intra fe reflexi conduntur, et ita conglobatur animal. In apice attollitur capitulum. A conglobato verme ad extremum folliculi umbilicale quafi vas producitur." The late Werner, as far as I know, was the firft who difcovered in the human body the fame kind of worms as thofe found in meafled fwine.

* This experiment was not long ago made with the beft confequences in the abbey of St. Urban, in the canton of Lucerne.

† See Lehmann's *Naturliche merkwürdigkeiten im Meiffnifchen Obererzgebirge*, p. 605.

which

which this animal has ſince degenerated, belong, with the original European race, to one and the ſame ſpecies; and ſince no bodily difference is found in the human race, as will preſently appear, either in regard to ſtature, colour, the form of the cranium, &c. which is not obſerved in the ſame proportion among the ſwine race, while no one, on that account, ever doubts that all theſe different kinds are merely varieties that have ariſen from degeneration through the influence of climate, &c. this compariſon, it is to be hoped, will ſilence thoſe ſceptics who have thought proper, on account of theſe varieties in the human race, to admit more than one ſpecies.

I. *In regard to Stature.*

In this reſpect the Patagonians *, as is well known, have afforded the greateſt employment to anthropologiſts. The romantic tales, however, of the old travellers, who give to theſe inhabitants of the ſouthern extremity of America a ſtature of ten feet and more, are ſcarcely worth notice; and even the more modeſt relations of later Engliſh navigators, who make their height from ſix to ſeven feet, have been doubted by other travellers, who, on the ſame coaſt, ſought for ſuch children of Enoch in vain. But we ſhall admit every thing ſaid of the extraordinary ſize of theſe Patagonians, by Byron, Wallis, and Carteret, the firſt of whom † aſſigns to their chief, and ſeveral of his attendants, a height of not leſs than ſeven feet, as far as could be determined by the eye; the ſecond ‡, who aſſerts that he actually meaſured them, gives to the greater part of them from 5 feet 10 inches to 6 feet; to ſome 6 feet 5 inches, and 6 feet 6; but to the talleſt, 6 feet 7 inches: and this account is confirmed by the laſt-mentioned

* Or rather Pata-chonians, for the people themſelves are called *Chonos*; and becauſe their feet, covered with raw hides, gave them a likeneſs to a bear's paws, they were called by the firſt Spaniſh navigators *patachonos*. See Forſter in *Comment. Soc. Scient. Gottingenſ.* vol. iii. p. 127.

† Hawkeſworth's Collection of Voyages, London, 1773. vol. i. p. 27.

‡ Ibid. p. 153.

of

of the above circumnavigators *. Now, allowing this to be the cafe, it is not near fuch an excefs of ftature as that obferved in many parts of America among the fwine, originally carried thither from Europe; and of thefe I fhall mention in particular thofe of Cuba †, which are more than double the fize of the original ftock in Europe.

II. *In regard to Colour, and the Nature of Hair.*

The natives of Guinea, Madagafcar, New Holland, New Guinea, &c. are black; many American tribes are reddifh brown, and the Europeans are white. An equal difference is obferved among fwine in different countries. In Piedmont, for example, they are black. When I paffed through that country, during the great fair for fwine at Salenge, I did not fee a fingle one of any other colour. In Bavaria, they are reddifh brown; in Normandy, they are all white.

Human hair is, indeed, fomewhat different from fwine's briftles, yet in the prefent point of view they may be compared with each other. Fair hair is foft, and of a filky texture; black hair is coarfer, and among feveral tribes, fuch as the Abyffinians, Negroes, and the inhabitants of New Holland, it is woolly, and moft fo among the Hottentots ‡. In the like manner, among the white fwine in Normandy, as I was affured by an incomparable obferver, Sulzer of Ronneburg, the hair on the whole body is longer and fofter than among other fwine; and even the briftles on the back are very little different, but lie flat, and are only longer than the hair on the other parts of the body. They cannot, therefore, be employed by the brufh-makers. The difference between the hair of the wild boar and the domeftic fwine, particularly in regard to the fofter part between the ftrong briftles, is, as is well known, ftill greater.

* Philofoph. Tranfactions, vol. lx. p. 20.

† F. S. Clavigero Storia Antica del Meffico, vol. iv. p. 145.

‡ Sparmann fays, the hair of the Hottentots is more woolly than that of the Negroes.

III. *In regard to the Form of the Cranium.*

The whole difference between the cranium of a negro and that of an European, is not in the leaft degree greater than that equally ftriking difference which exifts between the cranium of the wild boar and that of the domeftic fwine. Thofe who have not obferved this in the animals themfelves, need only to caft their eye on the figure which Daubenton has given of both.

I fhall pafs over lefs national varieties which may be found among fwine as well as among men, and only mention that I have been affured by Mr. Sulzer that the peculiarity of having the bone of the leg remarkably long, as is the cafe among the Hindoos, has been remarked with regard to the fwine in Normandy. "They ftand very long on their hind legs," fays he, in one of his letters; "their back, therefore, is higheft at the rump, forming a kind of inclined plane; and the head proceeds in the fame direction, fo that the fnout is not far from the ground." I fhall here add, that the fwine, in fome countries, have degenerated into races which in fingularity far exceed every thing that has been found ftrange in bodily variety among the human race. Swine with folid hoofs were known to the ancients, and large herds of them are found in Hungary, Sweden, &c. In the like manner the European fwine, firft carried by the Spaniards in 1509 to the ifland of Cuba, at that time celebrated for its pearl fifhery, degenerated into a monftrous race, with hoofs which were half a fpan in length *.

* Herrera Hiftoria de las Indias Occident. Madrid 1601, vol. p. 239.

X. *Account*

X. *Account of the Method of making Sugar from Beet Roots, lately discovered by* M. ACHARD. *Communicated by* A. N. SCHERER, *Counsellor of Mines to the Duke of Saxe Weimar.*

Weimar, 14th Feb. 1799.

THE neweſt and moſt important diſcovery in Germany is that of the well known M. Achard, director of the phyſical claſs of the Academy of Sciences at Berlin, who has at length found a ſubſtitute for ſugar in the beet root, (*Beta vulgaris*, Linn.) Theſe beets in this country have been hitherto employed as fodder for cattle. The following is one of his principal experiments:—Twenty-five roots, which in their raw ſtate weighed 32½ pounds, being freed from the rind, bruiſed, and well preſſed, gave, after the reſiduum had been extracted by boiling water, 19¼ pounds of juice. The expreſſed juice was then put into a tin ſaucepan, and evaporated to the conſiſtence of honey over a ſlow fire. During this proceſs the impurities contained in the juice, and which aroſe from the albumen of the beets, were ſcummed off. The inſpiſſated ſalt was next evaporated to dryneſs over a ſlower fire, and gave, when pounded, a dry powder of a very bright brown colour, which attracted little or no moiſture; it was exceedingly ſweet, without the intermixture of any other taſte, and weighed two pounds three ounces. The above quantity, viz. 32½ pounds of the raw roots, gave, therefore, two pounds three ounces of raw ſugar. By another experiment it appeared, that a pound of this juice contained only ¾ of an ounce, or at moſt one ounce of gummy and mucilaginous particles: a circumſtance which greatly facilitated the ſeparation of the ſugar. To obtain a portion of pure ſugar from a quantity of juice evaporated and treated as above deſcribed, a portion of the juice, inſpiſſated to dryneſs, was digeſted with a ſufficient quantity of alcohol in a gentle heat; and after all the ſaccharine matter was diſſolved, and the liquor had become perfectly cold, it was filtred

and

and the refiduum properly edulcorated with a fuitable quantity of alcohol. When all the fpirit of wine had evaporated * over a gentle fire, the quantity of the pure white fugar obtained was fuch that in general 8 pounds of pure fugar may be expected from 100 pounds of raw beet roots. According to this refult, an acre of land, which may produce 46,000 pounds of beet root, will yield 22 hundred weight of raw fugar. If we allow four pounds of beet root to one fquare foot, a German mile will produce 16,756 hundred weight 2 quarters and 14 pounds. This is all as yet known refpecting the difcovery. What M. Achard ftill keeps fecret is the refult of his fifteen years experience refpecting the cultivation of thefe beets. He has found that the quantity of fugar to be obtained will depend on the foil in which they are fown, and the method of culture employed. The king of Pruffia has not only beftowed a confiderable reward on M. Achard for this difcovery, but is purfuing every poffible means to render it beneficial to his dominions.

XI. *Defcription of an Improved Machine for Cutting Chaff* †, *invented by Mr.* ROBERT SALMON, *of Woburn, Bedfordfhire. From* Tranfactions of the Society for the Encouragement of Arts, &c. *Vol. XV.*

WITH this machine the chaff is cut by two knives, A A, (Plate VI.) fixed on the infide of the fellies of two wheels, B B, which are ftrongly connected together; the edge of the knives being at an angle of about forty-five degrees from the plane of the wheel's motion. Thefe knives are fo fixed as to be forced forward by fprings, C C, on the wheel; which fprings are formed to adjuft, and act more or

* Diftillation might be employed to fave the lofs of the alcohol. EDIT.

† Thirty guineas were voted to Mr. Salmon for this improved machine, of which a model is referved in the Society's repofitory for the infpection of the public.

lefs

lefs as occafion may require, fo as to give the knife as much preffure againft the box as may be requifite to cut the ftraw. The knives are prevented from coming too forward, and occafioning unneceffary friction, by the wedges under the ftaples *a a*; which wedges, as the knives wear, muft be drawn out fo as to admit the knives to come more forward. With the before-mentioned provifions it will be found very eafy at any time to put on new knives, as the fprings, &c. will always adjuft them to their work.

On one fide of the wheel is fixed a round block of wood, D, in which there are four holes and a moveable fcrew; to this block is fcrewed one end of the feeding-arm, E, running nearly horizontally to the crofs bar F, at the end of the box G; to which crofs bar E is attached by the pin *b*, moveable to five different holes in F, by means of which, and the four holes in the block before defcribed, twenty changes in the length of the chaff may be obtained. The ftraw is brought forward by the rollers in the box G, the form of which is fhewn at Fig. 2; which rollers are turned from the outfide by the riggers or ratchet-wheels, H, one on each fide the box, which move more or lefs, according to the ftroke given to the crofs bar by the feeding-arm and wheel: by this mode of feeding, the ftraw is perfectly at reft, and does not prefs forward at the time of the knife cutting; and, by means of the pin being taken out of the crofs bar, the feeding is inftantly thrown off, although the wheel and knives may continue their motion. Under the box is fufpended the preffing weight I, which may be made more or lefs powerful by fhifting the weight on the bearer K, to which it hangs, and alfo may be thrown on either fide, more or lefs, as occafion may require; which will be found ufeful, in order to force the ftraw towards the knife, and to counterbalance the ratchet-wheel of the upper roller: near the fulcrum of this bearer is fixed a chain, fhewn by the dotted line *c*; its upper end fufpended from a roller; at each extremity of which is a fmall bar of iron joined to the end of the upper ſpiked roller, by which means the ſtraw is always equally preſſed in paſſing the two-ſpiked rollers.

L. The winch by which the machine is turned.

M M. The frame of the machine.

In order to apply this machine to the beſt advantage, the inventor propoſes a ſecond box to be placed at the end of the firſt, which box may be of any length, and ſuſpended by a line and counter-weight, whereby the end of it is brought down level whilſt filling with ſtraw, and then drawn up, ſo as to give the ſaid box a declivity, to make the ſtraw more eaſily come forward.

It is alſo preſumed much advantage may be expected in this ſort of machine, from its cutting various lengths—reſting during the cut—the knives being adjuſted to their work by regulating ſprings—the feeding being readily thrown off—and the preſſure moveable to either ſide.

It is alſo well calculated to be applied to any power which may be occaſionally fixed to the oppoſite ſide of that on which it is turned by hand; and, by the additional box, when uſed by hand, the workman will be enabled to cut for ſome continuance, without ſtopping to feed.

XII. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth. By* M. DE SAUSSURE. *From* Journal des Mines. *No. XX.*

[Continued from page 156.]

CHAP. XII.

Obſervations to be made on the Valleys.

1. TO obſerve the direction of valleys. Thoſe parallel to the chain of the mountains where they are ſituated are called longitudinal; thoſe which interſect it at right angles, tranſ-

verſal;

verſal; and thoſe which follow an indeterminate direction, oblique.

2. To obſerve this direction, eſpecially in regard to that of the planes of the ſtrata of the mountains.

3. Dimenſions of the valleys; their length, breadth, depth, and the form of their tranſverſal ſection.

4. The re-entering and ſalient angles: whether oppoſite to each ſalient angle, which forms a ſide of the valley, the ſide or oppoſite mountain forms a re-entering angle; or, on the other hand, whether the valley does not preſent alternate conſtrictions and ſwellings?

5. Whether the oppoſite mountains correſpond by their height, their form, the inclination of their correſponding faces; the ſituation of their ſtrata, or their nature?

6. Anſwers to theſe queſtions will ſerve to determine whether the valley may or may not be conſidered as a large fiſſure produced by the burſting aſunder of the mountains which it traverſes.

7. If the lateral valleys which terminate at a principal valley, as the branches of a tree at its trunk, correſpond or not; or, in other words, whether the branches of that trunk are oppoſite or alternate?

The anſwers to theſe two queſtions are very important for the ſolution of this queſtion: Whether the valleys have been excavated by currents of the ſea?

9. Whether there are ſeen a great number of narrow valleys, of no great depth at their moſt elevated part, but becoming wider and deeper in proportion as they deſcend lower, which would ſeem to indicate that their excavation has been the effect of the fall and deſcent of water; eſpecially if the ſtrata have the ſame inclination on each ſide of the valley, and if its formation cannot be explained by a ſinking down or heaving up of the earth.

10. To obſerve in a valley, the correſponding mountains of which are of the ſame nature, whether the ſtrata of the mountains do not deſcend on each ſide towards the botto

of the valley, which would indicate that the valley has been produced by a finking down of the earth, or perhaps by the oppofite faces being thrown up.

11. There are two other cafes poffible when the ftrata have not the fame fituation on both fides of the valley. 1. When the ftrata rife up on each fide againft the valley. 2. When on one fide they defcend into the valley, and on the other rife againft it. Thefe two cafes afford room for fuppofitions too various to be here detailed.

12. To fearch on the vertical fides of the valleys for veftiges of the erofion of the water.

13. To obferve the bottom of the valley, its breadth, inclination and nature. The vegetable earth, its quantity and quality; fragments, either from neighbouring mountains, or brought from a diftance, either angular or rounded; to examine whether they are more voluminous towards the top of the valley. Nature and depth of the ftrata which are below the vegetable earth; whether the pebbles are larger in the deepeft ftrata: nature of the rock which forms the folid bafis of the valley.

14. Whether a valley contains foreign pebbles, that is to fay, which come from the neighbouring mountains: to examine to what height they are found on the fides of the mountains; what may be their origin, and what way they may have been conveyed.

15. In the valleys which contain no foreign pebbles, one may follow the traces of thofe which are there difcovered, and thus afcend to the rock from which they were detached: this has often led to curious and ufeful difcoveries.

CHAP. XIII.

Obfervations to be made on Tertiary Mountains, or thofe compofed of the Wreck of other Mountains.

1. Whether they do not form the external border of other chains of mountains.

2. Whether, at the extremity of great valleys which iffue from

from grand chains of mountains, there are not found fmall hills and even tertiary mountains, which feem to have been formed by the accumulation of matters depofited by enormous currents that iffued formerly from thefe valleys.

3. Whether their ftrata do not defcend on the fide, whence the matter of which they are formed has proceeded?

4. Size and nature of the fragments, fand and earth, of which they are compofed.

5. To obferve the order which has been followed in the fucceffive depofits of the matters of which they are formed.

6. To compare them with the fubftances produced by the mountains, whether primitive or fecondary, from which they are fuppofed to have iffued.

7. To examine whether there are found there any veftiges of organifed bodies.

8. To examine whether there are not found, in their exterior part or furface, ftrata that feem to have been depofited by ftagnant water, or at leaft water not much agitated; or, on the contrary, whether every thing in them feems to have been tranfported by fome violent movement?

CHAP. XIV.

Obfervations to be made on Secondary Mountains.

1. To determine with precifion the diftinguifhing characters between primitive and fecondary mountains. This is difficult, efpecially in the genera found equally in primitive mountains, fuch as flate, ferpentines, and fome kinds of *trapps* and porphyry. With regard to the calcareous, a granulated fracture feems to characterife the primitive. M. Fichtel, however, doubts this principle, and believes that there are fecondary granulated, calcareous, and compact primitives,

2. Is it certain, as Dolomieu afferts, that in fecondary mountains there are no ftrata compofed entirely of granulated and cryftallifed ftones?

3. To determine the reſpective antiquity of the genera and ſpecies of the earths and ſtones which enter into the compoſition of ſecondary mountains. Might we not aſſign characters by which, in the ſame genus, we might diſtinguiſh the moſt modern ſpecies and varieties?

4. Whether the ſecondary mountains are always inclined in ſuch a manner as to lean towards the neareſt primitives?

5. Whether their ſuperior ſtratum, eſpecially in the compact calcareous, is not often a *breche**, the angular fragments of which are for the moſt part of the ſame nature as the ſtratum that ſerves them as a baſis, and united by a cement of the ſame nature†?

5. (A). To obſerve in the chalk mountains the flints contained there; their bulk, their form, &c.; whether they are diſpoſed in beds; to reflect on their origin: even reſearches on the petro-ſilex contained in the compact calcareous ſtones; and, laſtly, the ſame on the hard *rognons*, or touch-ſtones contained in the ſlate mountains: to aſcertain whether theſe petro-ſilex and rognons are not found in the primitive mountains.

6. Whether there are found in ſecondary mountains veſtiges of organiſed bodies, and at what elevation. This obſervation is important above all in the Auſtral hemiſphere‡.

7. Whether there are found, either at their ſurface, or in their interior parts, rolled pebbles or blocks of a nature different from that of the ſame mountain, and to what height‖?

8. Whether theſe mountains ſeem to have been formed by the alluvion of violent tides, or by the accumulated depoſits of ſtagnant water?

9. Whether the ſecondary mountains do not preſent them-

* Breche is a kind of hard marble found in the Pyrenees.

† Voyage dans les Alpes, vol. i. § 242. A. and 243.

‡ 6. A. Do not organiſed bodies contribute ſometimes to the hardneſs of ſtones, eſpecially thoſe that contain iron, by bringing that iron near to the metallic ſtate? *Hypotheſis of Gad in Mem. of the Acad. of Sweden*, 1787. c.

‖ See Dolomieu's Memoir Journal de Phyſique 1791, vol. ii.

ſelves

ſelves ſometimes in vertical ſtrata, or at leaſt ſtrata very much inclined, and with ſharp naked peaks like thoſe of ſome primitive mountains?

10. Whether, in the ſame ſecondary mountain, there are found ſtrata of different kinds of ſtones oftener than in the primitive?

11. Whether, in ſecondary mountains, on the other hand, each ſtone is not generally ſimple, and not compound as in the primitive?

12. To make reſearches reſpecting the origin and antiquity of mountains of gypſum, and their relation with mountains of ſalt and ſalt ſprings.

[To be continued.]

XIII. *Fourth Communication from Dr.* THORNTON, *Phyſician to the General Diſpenſary, relative to Pneumatic Medicine.*

Letter to Dr. Thornton.

DEAR SIR, Dulwich Common.

I RETURN you many thanks for your kind attentions to Mrs. R. Your method of treatment, under Providence, has certainly performed a wonderful cure. My wife had not inhaled the air three times before I perceived a very great alteration, both in regard to *appetite* and *ſpirits*; her *ſtrength*, in a week, was alſo ſo much reſtored that ſhe could with eaſe walk five miles, when before it was quite a fatigue to walk one. I can with pleaſure likewiſe add, that what alarmed us both—the *coldneſs* of her extremities, and *blackneſs* under the finger-nails—are both entirely removed, and her nails now appear healthy. As my wife has not enjoyed ſuch good health for ſeveral years as ſhe has experienced theſe laſt ſix months, Mrs. R. unites with me in grateful acknowledgements to you.

And I remain, dear ſir, your's reſpectfully,

M. ROBINSON.

Obſervations. This lady, reſiding in a country ſeat, which has a delightful garden, and a good deal of ground attached to it, in an open ſituation, could not be ſuppoſed to want vital air in the blood. Such, however, appeared to be the fact. In ſuch caſes I find by the eudiometer, that *the blood is in fault,* attracting but ſlowly into its boſom the vital principle. But as even the moſt apparently incombuſtible bodies readily deflagrate in pure oxygen air, as ſteel, &c. the ſame phenomenon might be expected in the human frame; and in the preſent inſtance we ſee that this was actually performed. The good, however, of a temporary inhalation of a ſuper-oxygenated air would have been loſt, unleſs the blood had been altered. Steel was therefore enjoined, together with what is ſtyled the phlogiſtic regimen; and the event exactly correſponded with my expectations—the radical defect was obviated, the attractive power in the blood was improved, and the blood, coming into contact with a ſuper-oxygenated atmoſphere, readily imbibed a large proportion of vital air. The blackneſs under the finger-nails in conſequence ſoon diſappeared, the appetite became quickened, the ſpirits were increaſed, and the blood freely paſſing from the centre to the circumference, and from the circumference back again to the heart, the phlogiſtic particles decompoſing the vital air in the blood in its paſſage, hence the extremities, and the whole body, became permanently warm. —As the above caſe may ſeem to ſome not ſufficient to argue much in favour of pneumatic medicine, I ſhall beg leave to lay before the philoſophic world the following extraordinary cure:

A CASE OF MELANCHOLIA.

Mr. Blundel, æt. 49, a wholeſale linen-draper on Holborn Hill, was ſubject to melancholia above thirty years; that is, he had frequent depreſſion of ſpirits, without any aſſignable cauſe; and this lowneſs was not caſual, but would remain for months with great languor, and was accompanied frequently with a diſtaſte of every thing before agreeable.

able. Mr. Blundel's only relief was a journey into the country, which he was accuftomed to take every year. Having two very eminent phyficians as half-brothers, the celebrated chemift Dr. Bryan Higgins, and Dr. Haighton phyfician to the Eaftern Difpenfary, the moft eminent phyfiologift of this country, every thing that the art of medicine could do had been employed, but without any material advantage. Mr. Blundel wifhed, therefore, to make trial of the vital air; and he inhaled it at firft under the management of a felf-taught genius, his neighbour Mr. Varley, of Hatton-Houfe, Hatton-Garden, and found at that time "an increafe of ftrength" and "his fpirits mended." But what ftruck him moft was, "an iffue which ufed to difcharge was, fince his commencing the air, completely dried up. Another thing he remarked, "that after walking he had varicofe tumours in the veins of his legs; but that thefe did not appear, even after a long walk, fince he had inhaled the vital air." I will felect a few more obfervations, as made by Mr. Blundel.

"September 20. Spirits much enlivened after taking the vital air.

"September 22. The fame good fenfations have continued, although I did not take the air yefterday.

"September 23. Found my mind tranquillized, and fomewhat elated towards evening; and when I awoke the next morning, perceived a general glow over the body; the feet, which ufed before to be always cold, were comfortably warm; the fingers glowed to their extremities, and I could clafp them with firmnefs; before, they would feel cold and numbed, and I was obliged to rub them before I could clofe them. All my family obferve that my countenance looks lefs fallow.

"September 25. Spirits continued throughout the day very good. Sleep grateful.

"September 26. The fame to-day.

"September 27. The fame obfervations to-day."

I fhould mention, that when Mr. Blundel applied to me, I defired him to continue the air with Mr. Varley, and ordered

dered a feton in the neck, as the iffue was dried up. I directed alfo bark, columbo, and prepared kali, to correct acidity and brace the ftomach, as alfo to render the blood more attractive of oxygen, and the body was kept regular with aloetic pills; and this plan fpeedily produced the bleffing of found health, which has continued now upwards of fifteen months, without any difagreeable nervous fenfations, and without a fingle excurfion being made into the country.

Obfervations on this Cafe. In the cafe of Mr. Ruffel, which was melancholia, recorded by Dr. Beddoes, the cure was effected without a feton; how much are we therefore to attribute to this application in the prefent inftance? The drying up the iffue by the vital air, when employed alone, did it not denote, from the abforption of this principle, an increafed energy of the abforbents? I have before noticed, that where ferum was difcharged, this has happened; but when matter is fecreted, there is on the contrary a more abundant difcharge, or the ferum is converted into laudable pus. In the cafe of Mr. Fixfen, St. Anne's-Street, Weftminfter, an iffue which could not be made to difcharge, began immediately to pour out matter, upon the commencement of the inhalation of the medicinal air. The varicofe veins difappearing was a ftrong mark of increafed energy in the circulating veffels. The numbnefs of the fingers going off, fhewed increafed action remote from the heart; the glow, the increafe of fpirits, all declare in marked expreffions the influence of vital air; and what makes me the more inclined to this opinion is, that *country air* before ufed to afford the only relief.

XIV. *Account of the New Machine invented by the late Mr.* CUSTANCE, *for making Vegetable Cuttings for the Microfcope. Communicated by* DR. THORNTON, *Lecturer on Medical Botany at Guy's Hofpital, &c. &c.*

THE firft idea of making vegetable cuttings to be examined by the microfcope, originated from the famous Dr.

Dr. Hooke above a century ago, as may be ſeen in his Micrographia.

"Charcoal, or a vegetable burnt black," ſays this eminent philoſopher, "affords an object no leſs pleaſant than inſtructive; for if you take a ſmall round piece of charcoal, and break it ſhort with your fingers, you may perceive it to break with a very ſmooth and ſleek ſurface, almoſt like the ſurface of black ſealing wax: this ſurface, if it be looked on with an ordinary microſcope, does manifeſt abundance of thoſe pores, which are alſo viſible to the eye in many kinds of wood, ranged round the pith, both in a kind of circular order, and a radiant one. Of theſe there are a multitude in the ſubſtance of the coal, every where almoſt perforating and drilling it from end to end; by means of which, be the coal ever ſo long, you may eaſily blow through it; and this you may preſently find, by wetting one end of it with ſpittle, and blowing at the other.

"But this is not all: for, beſides thoſe many great and conſpicuous irregular ſpots or pores, if a better microſcope be made uſe of, there will appear an infinite company of exceedingly ſmall and very regular pores, ſo thick and ſo orderly ſet, and ſo cloſe to one another, that they leave very little room or ſpace between them to be filled with a ſolid body; for the apparent interſtitia, or ſeparating ſides of theſe pores, ſeem ſo thin in ſome places, that the texture of a honey-comb cannot be more porous: though this be not every where ſo, the intercurrent partitions in ſome places being very much thicker in proportion to the holes.

"Moſt of theſe ſmall pores ſeemed to be pretty round, and were ranged in rows that radiated from the pith to the bark; they all of them ſeemed to be continued open pores, running the whole length of the ſtick; and that they were all perforated, I tried by breaking off a very thin ſliver of the coal croſs-ways, and then with my microſcope diligently ſurveying them againſt the light, for by that means I was able to ſee quite through them.

"These pores were so exceedingly small and thick, that in a line of them, $\frac{1}{18}$ part of an inch long, I found, by numbering them, no less than 150 small pores; and therefore, in a line of them an inch long, must be no less than 2700 pores; and in a circular area of an inch diameter, must be about 5,725,350 of the like pores; so that a stick of an inch diameter may containe no less than seven hundred and twenty-five thousand, besides 5 millions of pores, which would, I doubt not, seem even incredible, were not every one left to believe his own eyes. Nay, having since examined cocus, black and green ebony, lignum vitæ, &c. I found that all these woods have their pores abundantly smaller than those of soft light wood; in so much that those of guajacum seemed not above an eighth part of the bigness of the pores of beech, but then the interstitia were thicker; so prodigiously curious are the contrivances, pipes, or sluces by which the succus nutritius, or juyce of a vegetable, is conveyed from place to place."

He afterwards says, "I took a good clear piece of cork, and, with a pen-knife sharpened as keen as a razor, I cut a piece of it off, and thereby left the surface of it exceeding smooth; then examining it very diligently with a microscope, methought I could perceive it to appear a little porous; but I could not so plainly distinguish them as to be sure that they were pores, much less what figure they were of: but judging from the lightness and yielding quality of the cork, that certainly the texture could not be so curious, but that possibly, if I could use some further diligence, I might find it to be discernible with a microscope, I, with the same sharp pen-knife, cut off from the former smooth surface an exceeding thin piece of it; and placing it on a black object plate, because it was itself a white body, and casting the light on it with a deep plano-convex glass, I could exceeding plainly perceive it to be all perforated and porous, much like a honey-comb, but that the pores of it were not regular; yet it was not unlike a honey-comb in these particulars."

This is the firſt rude hint reſpecting the mode of cutting of vegetables, ſince which time cutting machines have been contrived by ſeveral ingenious mechanics, that might better perform this delicate operation. In 1770 Dr. Hill publiſhed a treatiſe, in which he explained the conſtruction of timber by means of vegetable cuttings examined by the microſcope; and he in that work gives an account of a cutting engine, in which a ſpiral knife is employed; the invention, he ſays, of Mr. Cummings. The late Mr. Adams, optician in Fleet-ſtreet, appears to have contrived a machine for cutting thin ſections of wood, in order that the texture thereof might be more viſible to the microſcope; and in his Eſſays on the Microſcope, he ſays, that this his invention was afterwards improved by Mr. Cummings. Notwithſtanding the application of Dr. Hill, and of others who attempted to bring this art to perfection, Cuſtance, a common carpenter from Ipſwich, ſurpaſſed every other, and, as Mr. Adams juſtly obſerved, continued unrivalled in his dexterity of preparing thin ſections of wood, having brought this art to the higheſt perfection. He cautiouſly kept his method a ſecret from every one, and various conjectures were made in what way he accompliſhed his unrivalled cuttings. When he was alive, I offered him fifty pounds for the diſcovery, to diſcloſe it to the world for the promotion of ſcience, and in order the better to accompliſh my views in my New Illuſtration of Linnæus, where the organiſation of vegetables is a particular object of conſideration *. When preſſed, he offered me the diſcovery for an hundred guineas, which thinking exorbitant, I gave up all thoughts of it; but, ſoon after dying, he left in his will, that every thing he poſſeſſed ſhould be put up to public auction; and, among other things, his invention of the cutting engine was particularly noticed in the catalogue. They were not, however, expoſed to examination, but I did not fail being at the ſale to embrace this opportunity of bidding for the two engines, fearful that a mo-

* Repreſentations of all the Cuttings of Cuſtance will be given in this Work.

nopoly might be made of the art of preparing vegetable cuttings, as had been successfully done by Custance. Although the opposition was strong, I was the successful bidder, and became possessed of both engines, which are constructed nearly upon the same principle; and I am happy to embrace the present opportunity of communicating to the public so valuable an acquisition to philosophy and science.

Custance's best Cutting Engine described.

Fig. 1. represents a view, and fig. 2. a section, of the cutting machine. It has the appearance of an oblong box, and the sides from the bottom A (fig. 2.) up to B are made of brass. A piece of hard mahogany, C C, is fitted into the brass box, and fills the whole cavity down to *a a*, leaving a void space at the bottom, of sufficient size to admit the parts of the machine which work there, and which are described below. From the top to the bottom of the wood there is a perforation, of which the outline of fig. 3. may be considered as representing a horizontal section, which receives easily a brass socket, fig. 3, in which the wood (*b*) to be cut is secured in its place by means of a brass holdfast *c*, grooved like a float file, and pressed against the wood by the screw *d*. This socket, with the holdfast, (which viewed in front has a fluted appearance) and the piece of wood is represented in its place D, fig. 1 and 2, where it is secured from shaking by means of the piece *e*, fig. 2, pressed against it by the screw *f*, but not so tight as to prevent its being raised when required by the micrometer screw to be yet described. The socket, which fills the perforation from the surface D down to *g*, has a horizontal division at *h*, which serves as a bottom for the holdfast to rest on; the cavity of the socket below *h* receives a piece of metal *i i*, of which fig. 4, is an horizontal section; through this piece, which moves easily up or down in the socket, is a female screw, in which the micrometer screw turns, which may be seen passing through *i i* in fig. 2. The micrometer screw, the neck of which works in a plate *m m*, made fast to the bottom of the piece of mahogany before described by means of the

screws

ſcrews *n n*, is prevented from riſing or falling, when turned round, by a conical ſhoulder fitted into the upper ſide of the plate *m m*, as may be ſeen in the figure, and by the micrometer index wheel *o o* made faſt to that end of the ſcrew which projects through the lower ſurface of *m m*. Therefore, when the index is turned, the ſcrew working in *i* raiſes or lowers *i*; the latter by its form being prevented from turning with the motion of the ſcrew. The piece *i*, being thus raiſed as much as the intended thickneſs of the ſlip to be cut, preſſes as it riſes againſt the diviſion *h*, and by that means makes the braſs ſocket, in which the wood is made faſt as before deſcribed, to riſe exactly the ſame quantity—care being taken to regulate the preſſure communicated by the ſide ſcrew *f* in ſuch a manner as juſt to allow free action to the micrometer ſcrew, and yet to prevent any lateral deviation in the aſcent of the ſocket. A portion of the index wheel comes through the front of the machine (*o*, fig. 1.); and all that is neceſſary to raiſe the wood, the parts being previouſly adjuſted in the manner deſcribed, is to lay hold of the knob that preſents itſelf at the opening, and move it to the left, a half, a whole, or two diviſions, according to the thickneſs the ſlip is wiſhed to be cut. Theſe diviſions are marked on the circumference of the index, and you note the quantity that paſſes a ſtationary point marked over the centre of the opening.

The cutting apparatus is conſtructed in the following manner:—On the further edge of the upper ſurface of the box, a flat rule, G G, fig. 1, made of ſteel, is faſtened down by the ſcrews *k k*: it is more than an eighth of an inch in thickneſs, and the front edge of it is ground perfectly ſtraight, and ſtands at a right angle to the ſurface on which it reſts. Another flat rule, one end of which, H, may be ſeen projecting paſt the end of G towards the left, ſerves as a bed for the cutting knife *r r*, which is made faſt to the rule by the ſcrews *s s*. The upper and under ſurface of this rule are ground parallel to each other, and its back edge is ground ſtraight to fit againſt the front edge of the rule G G. The rule H, which is moveable with the knife *r r*, is tapered from the end H, ſo as to be ſomewhat narrower at the end next to the cavity D, than the diameter of the pieces of wood that can be contained betwixt the holdfaſt (*c*, fig. 3.) and the other ſide of the ſocket. From this the wonderful ſimplicity and accuracy of the proceſs, as performed by this apparatus, muſt be obvious; for the ſocket, or in other words the piece of wood from which the ſlip is to be cut, being raiſed to the deſired height by turning the micrometer *o*, all that is neceſſary is to ſlide the rule H, with an even hand and preſſure, along between the rule G G and the wood to be cut; the taper form of the knife, or rather of its bed, cauſing it to ſhave off, as the broad end comes nearer to the ſocket, a ſlip from the ſurface expoſed to its action. It ſhould be here remarked, that a portion of the bed (the rule H) is cut away from under the knife, from *r* to *r*, to allow the knife to paſs freely over the wood as it performs its office. To keep the wood perfectly faſt in its place while the ſlip is cutting off, beſides the holdfaſt in the ſocket already deſcribed, there is the following contrivance:—A braſs ſpur, *u*, a little thinner than the rule H, having a circular notch at its wideſt end, which may be moved or made faſt at pleaſure by means of the ſcrew *v*, is brought up tight againſt the wood to be cut (the wood being embraced by the circular notch), and then ſcrewed faſt; the opening at the narrow end of the ſpur, through which the ſcrew paſſes, is in the form of a ſlit, to allow it to be adapted with eaſe to different ſizes.

As the braſs ſocket riſes as well as the wood, (and this is indiſpenſible to ſecure the parallel riſing of the wood after each cut,) it muſt be obvious, that when, by being raiſed to allow taking off repeated cuttings, it has been brought almoſt to the knife, the apparatus muſt be re-adjuſted, and the wood raiſed in the ſocket before more cuttings be taken off.

It need hardly be remarked, that the cutting knife is ground

ground to a perfect true and fine edge, without warp or bend, that it may move through a perfect plane. The accuracy and delicacy with which it works may be judged by fig. 5, which represents a microscopic view of a cutting made from so fragile a substance as a *piece of charcoal*.

XV. *Remarkable Instance of a Turkey Cock hatching Eggs. By* M. OEDMANN. *From* New Transactions of the Academy of Sciences at Stockholm. *Vol. X.*

MALE fowls, which associate with a plurality of females, care so little for their posterity, particularly in a wild state, that they do not seem to have the least affinity to the young when hatched, and contribute neither towards rearing nor protecting them; on this account M. Oedmann considers the following circumstance to be very singular; such, perhaps, as was never before observed. In the month of May 1789 a turkey-hen was sitting upon eggs, and as the cock, in his solitude, began to be uneasy and to seem dejected, he was allowed to remain in the same place along with her. He immediately sat down by the female, and people at first believed that this was only a piece of gallantry; but they soon found that he had taken some of the eggs from under the hen, which he covered very carefully with his body. The maid, who looked after the poultry, thought this mode of hatching would be attended with little advantage, and therefore put the eggs back under the hen; but the cock was no sooner at liberty than he again carried some of them away as before. M. Haselhuhn, the proprietor, when he observed this, resolved, for the sake of experiment, to let the cock have his own way, and he caused a nest to be prepared with as many eggs as the animal's large body was able to cover. The cock seemed to be highly pleased with this mark of confidence, sat with great patience on the eggs, and was so attentive to the care of hatching them that he scarcely took time to go in search of

 food,

food. At the proper period 28 young ones were produced; and the cock, who was now in some measure the mother of so numerous an offspring, appeared a good deal perplexed when he saw so many little animals pecking around him and requiring his continual vigilance; but as it is well known that turkeys are so stupid and heedless that they often do not see where they tread, it was not thought proper to trust the cock with this young brood any longer, and they were reared in another manner. M. Carlson remarks on this circumstance, that the total neglect of their young, ascribed to male birds which associate with a plurality of females, is not general. Geese are of this kind, and yet the gander protects the young with the greatest care. But the instance of a turkey-cock sitting on eggs seems the more singular, as both in a wild and a tame state the males are accustomed to destroy the nests of the females, in order that they may have them sooner free for pairing; and for this reason the cock is carefully separated from the hen while she is hatching. The instance related by M. Oedmann is, therefore, the more remarkable.

XVI. *Method of securing Trees from the prejudicial Effects of Frost. By* P. J. B. DI SANMARTINO. *From* Giornale Encyclopedico di Vicenza.

THE surest and most proper method of protecting trees from the destructive influence of frost, is without doubt that which nature itself presents, and which requires to be only a little assisted by art; that is to say, you must deprive the tree, which you wish to defend from the frost, of all its leaves, at a period somewhat earlier than the time when they would drop of themselves. The sap then will be less accumulated in the vessels; it will circulate more slowly, and at the same time become thicker. In that case it will not freeze so readily, and even if it does freeze, its volume will not be enlarged so much as if it were thinner. M. Strömer made some experiments which seem to confirm the truth of this observation. He plucked the leaves from a few tender branches of a tree before the usual time of their falling; and the consequence was, that the branches thus stripped withstood a considerable degree of frost without sustaining any injury, while those which had not been deprived of their leaves artificially were destroyed. It is to be observed, however, in regard to this experiment, that all the leaves of the tree must not be pulled at the same time, but at three or four different periods some weeks distant from each other, yet in such a manner that the last of the leaves be removed before the usual time of their falling. Were they all pulled off at the same time, a sudden stoppage of the circulation of the sap would be occasioned, which would expose the tree to slow but certain destruction *.

* The following method of securing the blossom of fruit-trees from being damaged by early frosts, is mentioned in the Memoirs of the Royal Society of Agriculture of Paris. A rope is to be interwove among the branches of the tree, and one end of it brought down so as to be immersed in a bucket of water. The rope, it is said, will act as a conductor, and convey the effects of the frost from the tree to the water. This idea is not new, for the following passage may be found in Colerus: "If you dig a trench around the root of a tree, and fill it with water, or keep the roots moist till it has bloomed, it will not be injured by the frost. Or, in Spring, suspend a vessel filled with water from the tree. If you wish to preserve the bloom from being hurt by the frost, place a vessel of water below it, and the frost will fall into it." See his *Hausbuche* Wittenberg, 1608, 4to. vol. ii. p. 131; or the folio edit. of Franckfort, 1680, book vi. chap. 12, p. 203. EDIT.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

DENMARK.

THE Royal Academy of Sciences at Copenhagen, in consequence of Thot's and Claſſen's Inſtitutions, have propoſed the following queſtions as the ſubjects of prizes:

I. FOR THOT'S INSTITUTION.

The Society invites all thoſe competent to the taſk, its preſent members excepted, to tranſmit to it a complete eſſay, founded on experience, reſpecting any point of agriculture, to be choſen at pleaſure, ſuch for example as improving the cultivation of corn land, meadows, paſture grounds, or the planting of timber. It would give the Society particular pleaſure to receive complete anſwers to the following queſtions.

1. A catalogue, with the botanical and provincial names, of the different weeds, ſuch as the common corn-marygold, dog's-graſs, vetches, &c. which are found among the various kinds of grain, in any of the provinces ſubject to the Daniſh government; together with methods by which each of theſe weeds may be moſt effectually extirpated, and with the leaſt expence.

2. A circumſtantial account of the beſt proceſs by which poor or unfruitful ſoil, of a determined quality, may be ſo far improved as to be fit for cultivation; together with an eſtimate, calculated on an average of ſeveral years, of the expences and of the profits to be expected.

3. A proper defcription of the different varieties of potatoes, which, in proportion to the length of the fummer in Denmark, Norway, the Feroe ifles and Iceland, might be planted with the greateft advantage; which can afford the beft nourifhment for men and cattle, and whether, when ufed in moderation, they are found and wholefome food?

4. A defcription of the different kinds of oats, and their common varieties. Which of thefe, confidering the difference in the richnefs of the foil, and the greater or lefs care poffible to be employed in cultivating them, will be moft beneficial to the Danifh provinces?

The papers muft contain a clear botanical definition of the kinds mentioned. It will alfo be agreeable to the Society, if the author fend drawings of the varieties of the oats.

5. Though the Royal Chamber of Finance fet on foot the planting of young timber on the moors of Jutland, and the Economical Society encouraged that undertaking by premiums and other inducements, the Society does not think the following queftion fuperfluous: What means can be propofed for raifing plantations of trees with the leaft expence, and in the fureft and moft certain manner, on the heaths, moors, and other places unfit for corn land or meadows?

6. What are the kinds of grafs, befides red clover and ryegrafs, which can be ufed in Denmark for fowing in the fields and for improving the paftures?

The author muft give fuch a clear defcription of thefe productions as may be intelligible to farmers, together with the Danifh and Linnean fyftematic names, and fubjoin the different Danifh appellations under which they are known to the country people. He muft defcribe alfo the method of cultivating each kind; and if the plant be delineated in the *Flora Danica*, he muft refer to the figure. He muft likewife give the method of cultivating each plant; and where that is unknown, by defcribing its duration, the time of its blooming, the period of its maturity, and the foil it requires, endeavour to render the farmer capable of cultivating it.

7. The

7. The Agricultural Society long ago recommended the white hawthorn, buckthorn, barberry, hazel, crab-apple and willow for quickſet hedges; but as all theſe are not proper for the ſame ſoil, and as there is great want of quickſet hedges in the ſtoney, ſandy diſtricts expoſed to the wind, becauſe people are not acquainted with the kinds of trees that can be uſed, or with the method of planting them, though we poſſeſs indigenous as well as foreign trees of the buſh kind, which in this reſpect have been either tried in ſome places or may be recommended, the Society requires to know which of the tree or buſh kind, conſidering the different ſoils and diſtricts of Denmark, can be employed with the greateſt advantage for quickſet hedges, and what is the beſt method of planting them?

The author muſt give, along with the common and beſt known kinds, the Daniſh ſyſtematic names; thoſe leaſt known he muſt briefly deſcribe, and in ſuch a manner as to be underſtood by farmers. In both caſes he muſt give all the Daniſh trivial names, and the Linnean ſyſtematic appellation of each kind, with a reference to the figure in the *Flora Danica*, if it be there repreſented. The obſervations on the utility of each kind of wood for quickſet hedges, and the method of planting it, together with the determination of the ſoil which it requires, muſt reſt upon the grounds of certain experience.

Each of the papers on theſe ſubjects will be rewarded by the Society, in proportion to its novelty and the importance of the obſervations it contains, with 100 dollars; but the beſt and fulleſt, when more than one are tranſmitted, with 200 dollars.

II. For Classen's institution.

1. The inventor or improver of the moſt uſeful and beſt machine which can be employed, with moſt advantage, in agriculture, manufactures, or the mines in the Daniſh European

ropean poſſeſſions, will be rewarded by the Society with 200 dollars. The papers muſt be accompanied with proper models or accurate drawings.

2. For the conſtruction of harneſs, by which horſes, without being confined or hurt, may be able to draw in the eaſieſt manner, particularly when employed in agriculture, as in ploughing, harrowing, rolling, drawing corn-carts, &c.; and alſo in more laborious works, ſuch as drawing ſtone-carts, waggons, cannon, &c.; the Society will beſtow a reward of from 100 to 200 dollars, in proportion to the importance of the propoſed improvements.

The author muſt write his name and place of abode in a ſealed note, inſcribed with ſome device; and the papers with the ſame device muſt be tranſmitted, poſt paid, before the end of June 1799, to Profeſſor Abildgaard, ſecretary to the Society.

HOLLAND.

The ſecond Teylerian Society have propoſed the following prize queſtions for the year 1799:

As it is of great importance towards the improving and extending every branch of phyſics that the preſent ſtate of our knowledge in that reſpect ſhould be aſcertained, and that every thing which has been ſufficiently proved by experience ſhould be accurately diſtinguiſhed from what may be conſidered only as conjecture, the Society requires to know what is the preſent ſtate of our knowledge in regard to the aqueous vapours of the atmoſphere?—How far can we explain, on well founded experience, by what cauſes water is received into the atmoſphere in the form of vapour, or in any other manner, and retained there; and to what cauſes is it to be aſcribed that the water retained in the atmoſphere is diſengaged and falls down under different forms? Moreover, can all aqueous vapours be aſcribed merely to the diſengagement of the water in the atmoſphere, or have any obſervations

tions been made which clearly ſhew that water ſometimes is produced in the atmoſphere?

The Society will reward the author of that paper which ſhall treat this ſubject in the cleareſt manner, and throw moſt light upon it, with a gold medal of the value of 400 florins.

The anſwers muſt be written in the Dutch, Latin, French, Engliſh or German (but not with German characters) in the uſual manner, and tranſmitted with a ſealed note containing the name of the author, to the houſe of the Teylerian foundation at Haarlem, before the 1ſt of April 1800, that the prize may be adjudged before the 1ſt of November the ſame year.

As no anſwer was tranſmitted before the fixed period to the phyſical prize queſtion for 1797, the Society have thought proper to propoſe it a ſecond time. The prize is a gold medal of the ſame value as the above. The queſtion is as follows:

What certain knowledge have we reſpecting the nouriſhment and growth of plants; or how far can we at preſent conclude, from certain and deciſive experiments and obſervations, what the ſubſtances or principles are which chiefly afford nouriſhment to plants, and how they receive, ſecrete, and aſſimilate them?—What circumſtances relating to this ſubject, aſſerted by reſpectable philoſophers, are ſtill to be conſidered as doubtful?—By what experiments might our knowledge in this reſpect be with probability enlarged and confirmed?—And laſtly, What can be deduced from the knowledge here required reſpecting the nouriſhment and growth of plants, which might be practically applied in order to cultivate uſeful plants in many kinds of ſoil with more ſucceſs?

The chief object of the Society, in both the firſt diviſions of this queſtion, is, that the preſent ſtate of this part of our knowledge reſpecting plants may be accurately aſcertained, and that what is fully proved may be clearly diſtinguiſhed from

from what refts only upon weak grounds. The intention of this part of the queftion will therefore be fufficiently fulfilled, though the author may not be able to enrich his anfwer with new difcoveries.

Thofe who wifh to become candidates for this prize muft pay attention to fome of the modern publications upon the fame fubject, and in this refpect much information may be obtained from F. A. Humboldt's Aphorifms drawn from the chemical phyfiology of plants *.

GERMANY.

On the 13th of January laft the Mineralogical Society of Jena celebrated, at the ducal palace there, the firft anniverfary of their eftablifhment: on which occafion the director, Profeffor Lenz, gave a hiftory of the Inftitution, and of the progrefs of the Society; M. Samuel Nagy, fecretary of the Hungarian nation, read a chemico-mineralogical hiftory of Hungary; M. Von Ori of Kots in Hungary, delivered a congratulatory addrefs in Latin; M. Aarn of Leibitz, in Hungary, delineated a view of the great importance of mineralogy to Hungary; Dr. Von Gerftenberg fhewed the influence of mineralogy on the wants of human life and the profperity of fociety; and M. Panfner, of Arnftadt, gave a fhort view of the fuperftitious employment of many fpecies of ftones in ancient and modern times.

The fitting was clofed by the Secretary returning thanks to the members affembled for the part they had taken in promoting the object of the Society; and by M. von Pazmandi, of Bong in Hungary, expreffing his wifhes for the future fuccefs of the Inftitution.

His ferene highnefs the duke of Saxe Weimar and Eifenach has been pleafed to grant the Society permiffion to hold their future fittings in the large hall of the ducal palace,

* The title of the original is F. A. Humboldt's *Aphorifmen aus der Chemifchen Phyfiologie der Pflanzen*. Leipzig 1794, 8vo.

and

and to deposit their collection of minerals and books in the museum of Charles Augustus.

In the public sitting of March 3d, the director, Professor Lenz, read a short view of the latest discoveries in mineralogy; Dr. Von Gerstenberg explained the reasons which occasioned the regality of mines to be established; M. Pansner, of Arnstadt, controverted the grounds adduced for the Meisner † being of a volcanic nature; and M. Theil of Iglo, in Hungary, illustrated the influence which natural philosophy has on mineralogy.

BRITISH MINERALOGICAL SOCIETY.

The want of a Society in this kingdom, whose attention should be directed to the analysis and reduction of our native ores and minerals, has been felt for a considerable time. It is with pleasure, therefore, we announce that a Society under the above title has recently been instituted, which promises to be of considerable public utility; as it proposes to analyse, free of expence, for the proprietors of mines or landed estates, whatever substances they may meet with in sufficient quantity to render a knowledge of their component parts a desirable object. We hope, in our next Number, to be able to lay the plan of the Society before our readers.

† The Meisner is a mountain three miles from Cassel, which, according to measurement by the barometer, rises 1959 Paris feet above the surface of the neighbouring river, and 2184 feet above the level of the sea. Its upper part consists of masses of basaltes, some columns of which are 20 feet in length, and from 5 to 8 inches in thickness. It contains also coal. It has been declared to be of a volcanic nature by Faujas de St. Fond and Van Marum, who both examined it. EDIT.

MIS-

MISCELLANEOUS.

CHEMISTRY.

THE following proceſs for preparing *aurum muſivum* of a moſt beautiful quality has been announced by Brugnatelli: Precipitate a ſolution of the nitrat of tin by liquid ſulphure of potaſh, dry the precipitate and put it into a retort with half its weight of ſulphur and a quarter of the muriat of ammonia; you will then find the ſulphure of tin formed at the bottom of the retort, and of a moſt brilliant appearance.

In a former Number of this Work (Vol. II. p. 331), when laying before our readers an account of the preſent ſtate of Chemiſtry in Germany, we mentioned the favourable account given by M. Van Mons of Bruſſels, of the Elementary Treatiſe on Chemiſtry publiſhed by Profeſſor Gren, whoſe death we announced in our laſt Number. A letter which we have ſince received from M. Scherer of Weimar, ſpeaking of Mr. Gren's death and of his writings, ſays, "His Syſtem of Chemiſtry, on account of its perſpicuity and correctneſs, has obtained in Germany a decided preference over every other elementary work of the kind." This work we are happy to find has been tranſlated into Engliſh, and will ſoon be publiſhed in 2 volumes 8vo ſize. It contains all the facts relating to chemiſtry known up to 1796, as far as they come within the compaſs of an elementary treatiſe, explained on the principles of the new theory. The few diſcoveries ſince made have, we underſtand, been added by the tranſlator in occaſional notes; and, at the end, an account of the two new metals, Tellurium and Chrome.

EXCREMENT OF PLANTS.

Brugmanns, in a diſſertation on lolium * (darnel), was the firſt who proved that plants, like animals, free

* Diſſertatio de lolio, ejuſdemque varia ſpecie, noxa et uſu, 1785.

them-

themſelves from impure juices by the means of excretions *. He placed that plant in a tranſparent veſſel filled with water, and obſerved every day, at the extremity of the roots, a ſmall drop of a viſcous matter. This drop he removed, and next day there was another. All plants emit, in the ſame manner, from the extremities of their roots, and particularly during the night, ſmall drops of a liquid which is extremely prejudicial to them. It is hurtful alſo, very often, to thoſe plants which are near them; at other times it is uſeful to them: thus oats ſuffer much from the *ſerratula arvenſis*; flax, from the *euphorbia peplus* and the *ſcabious* of the fields; wheat, from the *erigeron acre*; ſarraſin, from the *ſpergula arvenſis*; and carrots, from *comfrey*.

Theſe phenomena may ſerve to explain why farmers are obliged to let their lands reſt a year; for, during that interval, this humour has time to be decompoſed. By the ſame means may be explained, why land exhauſted with one kind of plant cauſes others to vegetate with vigour: the fæces of the former hurt plants of the ſame ſpecies, and ſerve as manure to others. A field, for example, exhauſted with bearing clover, if ſown with wheat, will produce an abundant crop, becauſe the fæces of the clover are, without doubt, a manure for the wheat.

MINERALOGY.

A very ſingular ſpecies of iron ore has lately been diſcovered in Shropſhire, which may truly be conſidered as a national acquiſition. It yields, on the firſt reduction, *malleable* iron, inſtead of caſt iron, as is uſual from other ores; and the product is very large. From an hundred parts of it, previouſly torrefied, which we reduced in the aſſay furnace in the common manner, we obtained a malleable button which weighed ſixty-ſeven parts. The ſtratum, which is of

* *Plantas animalium more cacare primus exploravit vir indefeſſus Brugmanns*, ſays Humboldt in his Aphoriſms *Flora Fribergenſis*.

the great thickneſs of 2 feet 4 inches, was diſcovered when digging for coal.

Dr. A. N. Scherer, of Weimar, writes us, that Profeſſor Abildgaard, of Copenhagen, has lately obtained from Greenland a foſſil, which, on analyſis, is found to contain alumine in combination with the fluoric acid—a mineralogical phenomenon not before met with.

Sulphat of ſtrontian, which has hitherto been ſo ſcarce an article in this country, has lately been found in great quantities in the neighbourhood of Briſtol. It was at firſt believed to be merely a variety of ſulphat of barytes, till Mr. William Clayfield, wiſhing to obtain ſome muriat of barytes, reduced a portion of the mineral in the muriatic acid, when its great ſolubility, with its needle-formed cryſtals, ſoon indicated the preſence of ſtrontian. In the neighbourhood of Ham-green a variety of this rare production is found breaking through the ſoil in ſuch large maſſes that it has been made uſe of in mending the roads.

PHOSPHORESCENCE OF WOOD.

Dr. Carradori, in a paper on the phoſphoreſcence of wood, aſſerts that phoſphoric wood acquires by putrefaction the property of attracting and abſorbing light, and of retaining it mechanically. To make it ſhine, it is ſufficient to expoſe it for ſome time to the ſun. A bit of wood, which the author examined, continued to ſhine under oil for two whole days. In that ſituation, ſays Dr. Carradori, it was not in contact with oxygen gas.

DIURNAL MOTION OF THE EARTH.

In a work lately publiſhed, entitled, *De diuturno terræ motu experimentis phyſico-mathematicis confirmato,* with ninety copper-plates, the author, Profeſſor J. Baptiſta Guglielmi, of Bologna, giving an account of ſeveral experiments which he made on the falling of heavy bodies, ſays, that, in a height of 241 feet, he found a deviation of

 8½ lines

8½ lines towards the eaſt, from a perpendicular direction, which amounts exactly to as much as, according to his calculation, is produced by the diurnal motion of the earth. De la Place, of Paris, diſputes a part of this deviation, and, according to his calculation, admits no more than five lines. This is adduced as a new proof of the rotatory motion of the earth.

PHYSIOLOGY.

Dr. Carradori, in a letter to M. Laſti on the digeſtion of nocturnal birds of prey, conſiders it as fully eſtabliſhed that theſe birds digeſt vegetables. It reſults from his experiments, that they can be ſupported extremely well with that food, though it is repugnant to their nature. Dr. Carradori has therefore deſtroyed the erroneous opinion that the gaſtric juice of theſe animals had an affinity only for animal ſubſtances: what he eſtabliſhes by his experiments, that carnivorous animals find nouriſhment in the produce of plants, was before rendered probable by the diſcovery made by Fourcroy of the exiſtence of gluten, albumen, and gelatinous matter in vegetables.

The ſame author has aſcertained, by new experiments, that breathing is neceſſary to aquatic frogs for the ſupport of life. He obſerved, that theſe animals held under water lived a much longer time when the jars were open than when they were ſhut, and that their exiſtence was prolonged in proportion to the volume of the air around them. Under water covered with a ſtratum of oil they lived only a ſhort time. In pure oil they died in the courſe of 40 minutes. The author was deſirous to try alſo how far water was neceſſary for ſupporting the life of theſe animals. He obſerved, that frogs kept in water up to the belly died a third ſooner than thoſe kept entirely dry. Fiſh incloſed in a jar partly filled with air, conſumed none of that fluid.

MEDICAL

MEDICAL LITERATURE OF THE NORTH.

Professor Pfaff of Kiel, and Dr. Scheel of Copenhagen, have announced a new periodical work, the object of which is to give an account of every thing that relates to the state of medicine in the North, under which the editors comprehend the Danish States, including Holstein, Sweden, and the northern part of Russia. The work will embrace surgery as well as medicine, both in theory and practice; and physics and chemistry, so far as they are connected with these branches of science, will not be excluded from their plan, of which the following are the outlines. 1. The theory of medicine. 2. Practical medicine. 3. Surgery and midwifery. 4. Northern medical and chirurgical literature. 5. Medical institutions and medical policy of the North. 6. Intelligence. The editors have received assurances of support from the principal physicians in the North, among whom are Saxtorph, Abildgaard, Callisen, Hensler, Weber, Fischer, Hedin, Herholdt, &c. The editors do not mean to confine themselves to any regular periods of publication; but will endeavour to publish a number, consisting of twelve sheets, every three months. The first number was to appear at Easter 1799.

Dr. K. A. Rudolphi, also of Greifswald, has announced a work somewhat similar, to be entitled *Swedish Annals of Medicine and Natural History*; two numbers to be published annually, according as materials can be procured. The editor, who was born at Stockholm, means to make extracts from every work on medicine or natural history printed in Sweden; and as a copy of every Swedish publication of importance is procured for the academic library at Greifswald, he hopes he shall be able to give in these Annals a complete view of the present state of medicine and natural history in his native country. The first part was to be published at Easter 1799, by Lange at Berlin.

ASTRONOMY.

The following account of the objects discussed by Lalande and the German astronomers, &c. who met last summer at Gotha, has been published by Professor Bode of Berlin, in his Astronomical Almanack for the year 1801.

"In the month of January 1798, Lalande gave public notice that he intended, in the course of the Summer, to make a tour to Gotha, partly to see the celebrated observatory at that place, and partly to pay a visit to his learned friend and old correspondent Major Von Zach. On this occasion he wished, in particular, to form a personal acquaintance with several German astronomers, some of whom had long kept up an epistolary correspondence with him; and many of them, among whom I was one, received the most flattering invitation to meet him.

"I resolved to undertake this jaunt; to which I was encouraged, in particular, by M. Von Hahn of Remplin, who, however, was not able to accompany me. I accordingly obtained his majesty's permission, and having learned that Lalande, with his niece, Madame le Français, had arrived at Gotha on the 25th of July, I set out on the 7th of August, by Leipsig, Naumburg, and Erfurt; and on the 9th reached Gotha, where I had the pleasure of becoming personally acquainted with the long celebrated and meritorious French astronomer and his learned niece, and of embracing my worthy friend Von Zach. At the duke's court I met with the most gracious reception; but the unfavourableness of the weather deprived me, in a great measure, of the satisfaction of using the noble instruments in the observatory; for, during the time which I spent there so agreeably, the atmosphere was overcast, and storms and rain prevailed. The astronomers and others present were: Professor Klügel, Professor Gilbert, and M. Pistor secretary of the post-office, from Halle; Professor Seyffer, from Göttingen; M. Köhler, and M. Seyffert, from Dresden; M. Schaubach, from Meiningen; and M. Feer architect, from Zurich. The other

 German

German literati who had received an invitation, sent excuses for not accepting it.

"Among the various astronomical and mathematical objects discussed on this occasion were the following:

"Lalande wished that the decimal system some time ago proposed in France to be used in astronomical and mathematical calculations, in the division of time and of the circle, in instruments for long measure, in weights, coins, &c. might be introduced into Germany. We, on the other hand, represented to him the difficulties, in regard to common life, which opposed, and which would perhaps ever oppose, the general adoption of this system, otherwise useful in calculation; and that men of letters were the least of all fit to remove these difficulties: we, however, agreed that in future we would favour this system more in our writings, in order to make it better known; and we at the same time expressed a hope that the National Institute of Paris would transmit to us the new tables for the decimal calculation, as soon as they were published, which Lalande promised to use his interest to effect.

"He mentioned also the general adoption of the new standard proposed in France, called the *metre*, or the linear unity of 10,000,000 parts of a quadrant of the earth's meridian; because, in his opinion, it was borrowed from nature itself, and therefore was equally proper for all nations. But we could give him very little hope in regard to the introduction of the metre in Germany; especially as the French foot is already used in comparing measures, and its exact length every where known. We, however, resolved to give, in future, foreign measures according to the metre, as we formerly gave them by the French foot, as soon as the exact length of the former should be made known to us by the grand measurement now carrying on in France, but not yet completed*. We agreed also to give in future all calcu-

* This undertaking has been since finished. EDIT.

lations and astronomical observations, as well as the places of the heavenly bodies in astronomical books, for the mean time, as soon as the editor of the *Connoissance des Tems* should set us the example. Perhaps it will be possible also to introduce this mean time into common life, in order to effect a better regulation of the going of watches.

"Accurate and more numerous observations of the time of the moon's culmination were next recommended, as these might serve in determining the difference of meridians of places; also to insert in astronomical almanacks the time of the occultation of stars of the fifth and sixth magnitude, before the first, and after the last quarter of the moon, in order to give occasion to more frequent calculations of these differences. In calculating the oppositions of the superior planets, for examining the theory of their orbits, the same method must absolutely be followed; and that given in Lalande's Astronomy, section 4162, was here proposed.

"I produced a complete drawing of the fifteenth sheet, and the two engraved, but not yet finished sheets, tab. 11 and 12, of my large Celestial Atlas, and the manuscript of my Complete Catalogue of the Stars, and particularly the part respecting De la Caille's Southern Stars, which have never yet been numbered. Lalande took this occasion to observe that room might still be found on some of the celestial charts for new constellations, and wished to see inserted among the stars an aërostat, as the invention of the French. I embraced this opportunity, contrary to my former firm resolution of introducing no new constellations, to propose, on the other hand, that a German discovery, made 350 years ago, viz. the art of printing, might be perpetuated in the heavens by some emblem. Both proposals were approved. The first constellation will be inserted between the Goat and Southern Fish; and the other between the Ship, Unicorn, and Greater Dog.

"Lalande was convinced, at the same time, by ocular demonstration, of the accuracy of observations made with a

Hadley's

Hadley's ſextant on the Inſels Berge, one of the higheſt foreſts of Thuringia, where the ducheſs gave a fête to the company, and where we took ſeveral correſponding altitudes of the ſun with various ten-inch ſextants by Troughton, in order to determine the time and height of the pole.

" Lalande had with him a chronometer by Berthoud the elder at Paris. The duke of Gotha has in his poſſeſſion four Engliſh chronometers, by Arnold, Emery, Mudge, &c. Major von Zach has one by Emery, and M. Seiffert of Dreſden one made by himſelf. All theſe were compared with pendulum clocks, and with each other; and their rate of going was found to be remarkably regular, which proved that they were fit to be uſed in determining the longitude. Seiffert alſo ſhewed, merely to give pleaſure to Lalande, a clock conſtructed by himſelf, according to a new invention, and having marked on the dial-plate the diurnal diviſion of the day propoſed in France. He had likewiſe with him, of his own workmanſhip, a ſtop watch with the decimal diviſion, which he preſented to Madam le Français.

" Some new inſtruments and maps were alſo exhibited and examined. Among theſe were an ocular heliometer, to be applied to a Herſchel's teleſcope, invented by M. Köhler, and conſtructed by M. Seiffert; the diaphragms of the former, for determining the ſtrength of the light of the ſtars, and his propoſed veſſel for an artificial water horizon; a map of the Rhein Thals, laid down by means of a Hadley's ſextant, by M. Feer of Zurich; ſome ſheets of the new map of the duchy of Wurtemberg, by M. Bohnenberger of Tubingen, meaſured and delineated by means of like inſtruments. The beautiful inſtruments on the ducal obſervatory of Seeberge, near Gotha, and the convenient and proper manner in which they are erected, obliged Lalande to acknowledge that he had never ſeen any where an obſervatory ſo well furniſhed.

" Of the new French calendar, and their manner of reckoning by decades, as well as their propoſed decimal diviſion of the day, there was no discussion. Lalande himself must have been aware, that as the introduction of this innovation found, even in France, and particularly in the provinces, so great opposition, it would meet with much more in other countries. It would also hardly find admission among those who have still any regard for institutions which, thousands of years ago, the first law-givers and astronomers declared to be proper for civil life, and which have since been retained through all ages. Besides, this new French calendar, in making the year begin at the entrance of the sun into the equinoctial point, determined by astronomical calculation, brings it back upon no solid and sure grounds; while we, on the other hand, by the very simple method of intercalation, can determine common time backwards and forwards for many centuries, and differ only one day from astronomical time in the course of 3200 years."

The Elector of Saxony has enriched the observatory at Leipsic with a considerable number of astronomical instruments, which were before preserved in the mathematical hall at Dresden.

SYMPATHETIC INKS.

On this subject a correspondent has sent us the following communication:

"Many receipts have been already published for making inks, the writings with which remain *invisible* till brought forth by heat; but many inconveniences attend even the best of them. Having tried all I have been able to meet with, I have found that some require so much heat that the whole paper is scorched before the letters make their appearance; that in some the letters are indistinct when produced; and that in others the words are almost legible before the heat is applied. In the course of my experiments on this subject, I hit upon a very simple mixture which obviates these inconveniences; as the writing done with it is perfectly invisible till heat be applied, and becomes very black with such a de-

gree

gree of heat as will not injure the paper. It is alſo very durable, may be kept long before it is put to the fire, and will retain its colour long afterwards. It conſiſts of ſulphuric acid, and three times the quantity of water mixed together.

"The thing is ſo ſimple that I can hardly think it can be new: it was, however, unknown to me till I diſcovered it; and if it has not before been publiſhed, it may amuſe ſome of your readers.

"There is one inconvenience attending this ink, which is common to all of this nature: it injures the parts of the paper on which the letters are written. All theſe inks owe their property to ſome corroſive ſubſtance, which being acted upon by the fire, renders the writing viſible, by reducing thoſe parts of the paper on which the ink has been applied, to a kind of charcoal.

"*Cambridge, March* 29, 1799. J. D."

STATISTICS.

Liſt of the Births, Deaths, and Marriages, in ſeveral countries and cities of Europe, for 1798.

	Born.	Died.	Pairs married.
Abo in Sweden -	310	260	100
Amſterdam - -	6406	4769	2313
Augſburg - -	998	1163	325
Berlin - -	6206	5136	1070
Copenhagen - -	3351	3717	2238
Florence - -	3406	1696	——
Franckfort on the Mayne -	999	1002	310
Gothenburg in Sweden -	460	347	157
Groningen - -	960	646	308
The Hague - -	——	1466	563
Hamburgh - -	3512	3842	1492
Hanau - -	434	358	117
Hermanſtadt in Tranſylvania	392	374	116
Konigſberg - -	2203	2134	591

London

	Born.	Died.	Pairs married.
London - -	17927	18155	——
Magdeburg - -	1017	973	320
Mannheim - -	718	630	202
Munich - -	1682	1799	308
Pomerania, Pruſſian -	17717	11140	4349
Pruſſia, Eaſtern - -	32808	26826	8661
Rotterdam - -	1673	2025	666
Ruſſia, the Eparchy of Brazlaw excepted	991915	540390	257513
Sheffield - -	1646	1372	431
Stutgard - -	800	797	182
Thorn, Proteſtants -	179	103	139
Tubingen - -	228	146	72
Ulm - - -	570	525	169
Vienna - -	11595	13370	2765
Zealand without Copenhagen	8244	6807	——
The Dioceſe of Aarhuus -	4268	2359	1325
———— of Fühnen -	6205	4766	——
———— of Ripen* -	3851	2798	1110

Of thoſe who died at Viennâ, 1309 were carried off by conſumptions, 612 by the ſmall-pox, 472 by apoplexy, &c. The births exceeded the deaths by 1775. Of thoſe born at Berlin, 3038 were males, and 2968 females; 568 were born out of wedlock: there were alſo 66 pair of twins, and one inſtance of three at a birth. Of thoſe who died, 2414 were adults, and 2722 under age.

Of thoſe born at Konigſberg, 1159 were males, and 1044 females. Of thoſe who died, 1100 were males, and 1034 females. The births exceeded the deaths by 69. Among thoſe born were 12 pair of twins, and 399 born out of wedlock. Among thoſe who died, ten were between 90 and 100 years of age; and one man had attained to his 100th; 34 perſons loſt their lives by accidents.

* Theſe three dioceſes belong to Denmark. Edit.

6 Among

Among thofe who died in Pruffian Pomerania were two men and three women 100 years of age, and three men and four women of from 101 to 105.

Of thofe born in Ruffia, 531015 were males, and 460900 females: of thofe who died, 275583 were males, and 264807 were females. The births exceeded the deaths by 451525.

It is to be remarked here, in general, that the mortality in the Southern part of Europe is confiderably greater than that in the Northern part, London and Copenhagen excepted. The caufe of thefe forming an exception, is, perhaps, their being populous capitals.

MANUFACTURES.

M. Möglich, member of the privy council of Wirtemberg, lately deceafed, found out, a little before his death, a new method of making ropes, the threads of which are not twifted as ufual and wound round each other, but bound together ftraight and in a parallel direction. The celebrated Mufchembroek difcovered, by feveral experiments, that threads and cords, not twifted, formed ftronger ropes than thofe which were twifted; but he never could difcover a proper method of uniting parallel threads together. The brothers, Landauer at Stuttgardt, have, however, begun a manufactory of this kind, which will be of great utility for fhipping. It has been found by experiments that fuch a rope, wove of yarn worked together, $1\frac{3}{4}$ inch in diameter, fupported 13 hundred weight without breaking; and when it was at length made to give way by a greater weight, it broke as if it had been cut with a pair of fciffars; a proof that all the threads had experienced an equal degree of tenfion. A wove rope of this fort, containing 504 threads, $3\frac{3}{16}$ inches in diameter, and 111 feet long, weighed no more than 19 pounds, whereas a common rope of the fame dimenfions, and the like number of threads, weighed $31\frac{1}{2}$ pounds.

METEOR-

METEOROLOGY.

The fevere cold that prevailed during the courfe of the late winter, induced the celebrated aftronomer Lalande to publifh, in one of the French Journals, the following lift of years which were remarkable for the intenfenefs of the froft, viz. 763, 801, 1067, 1210, 1272, 1305, 1354, 1358, 1361, 1364, 1420, 1460, 1480, 1493, 1507, 1522, 1608, 1638, 1655, 1657, 1663, 1670, 1677, 1699, 1740, 1776, 1788.

ENGRAVING.

Lagarde, a bookfeller at Berlin, has begun an undertaking, never perhaps before attempted, at leaft in Germany. He means to publifh a Greek edition of Homer, entirely printed from copper-plates. Profeffor Wolf, at Halle, is to fupply the text, and the work will be executed with the utmoft care poffible. Jäck is to engrave the plates, from the beft fpecimens of Greek writing.

DEATHS.

On the 16th of December laft, at Halle, in the 70th year of his age, John Reinhold Forfter, LL.D. profeffor of natural hiftory in that univerfity, member of the academy of fciences at Berlin, and of other learned focieties. He was born at Dirfchau, in Weft Pruffia, in the month of October 1729, and was formerly a Proteftant clergyman at Dantzig, from which he went to Ruffia, and thence to England, where he purfued his favourite ftudy, Natural Hiftory. From 1772 to 1775 he accompanied Capt. Cook in his voyage round the world. On his return he refided at London, till he was at length invited to Halle, where, for 18 years, he was a member of the philofophical and medical faculties. Among his works are: *An Introduction to Mineralogy, or, An accurate Claffification of Foffils and Minerals, &c.* London, 1768, 8vo. *A Catalogue of the Animals of North America, with fhort Directions for collecting, preferving, and tranfporting all Kind of Natural Curiofities*, London, 1771, 8vo. *Obfervations made during a Voyage round the World, on Phyfical Geography,* &c.

&c. London, 1778. He was the author of a great many productions in Engliſh, Latin, or German, and of ſeveral papers in the Philoſophical Tranſactions. He tranſlated into Engliſh, Bougainville's Voyage round the World, and Kalm's, Boſſu's, and Reidſel's Travels. He was employed likewiſe, when in England, in the Critical Review; and he wrote various detached papers on different ſubjects, which have been inſerted in foreign Journals and the Tranſactions of learned academies. His ſon, George Forſter, who alſo went round the world with Capt. Cook, and was afterwards profeſſor of natural hiſtory at Caſſel, died at Paris, at the age of 39, on the 13th of February 1792.

Not long ago, at Hamburgh, the celebrated portrait and hiſtorical painter Hickel. He diſtinguiſhed himſelf particularly by his happy talent of giving good repreſentations of family ſcenes and children. He ſtudied at Vienna, and enjoyed there for a long time a conſiderable penſion, which Joſeph II. however at length withdrew. He reſided after this ſometimes in Swiſſerland, and ſometimes in London and Paris. The late queen of France often ſat to him, as did alſo the princeſs of Lamballe, who cauſed herſelf be painted ſometimes as a noſegay girl, and ſometimes as a fortune-teller or nun. In the year 1793 he began to paint a ſitting of the Britiſh houſe of commons, and moſt of the portraits were ſtriking likeneſſes. From this painting, which was 15 feet in breadth and 11 in height, he propoſed publiſhing a print by Cheeſeman; but, owing to ſome diſappointment in regard to the ſubſcription, the undertaking was abandoned. During the laſt days of his life he made a painting of Klopſtock, and exceedingly like. The poet is repreſented ſitting and reading one of his favourite odes. Hickel, at the time of his death, propoſed to have a print from this painting, 19 inches by 16, engraved by Huck.

At Geneva, on the 22d of January, Horace Benedict de Sauſſure, well known as a naturaliſt, chemiſt, and mineralogiſt. He was born in 1740, ſtood candidate for the mathematical

matical chair of that city in 1760, and in 1762 was appointed professor of philosophy. He was a member of most of the learned societies in Europe, and author of many works; among which are, *Travels through the Alps*, published first in quarto, and afterwards in octavo; *Essays on Hygrometry*, *Observations on the Epidermis of Leaves and Petals*, &c. For a list of his smaller treatises, see Senebier's *Literary History of Geneva*, vol. III.—M. de Saussure enriched natural philosophy also with two valuable instruments, a portable hygrometer and electrometer. He had in his possession a most beautiful cabinet of natural history; and an herbal, remarkable not only for the number of plants it contained, but also for their fine state of preservation.

On the 5th of February, at Bologna, in the 55th year of his age, the celebrated Galvani, from whom Galvanism, which has made so much noise in the philosophical world, took its name. It is said that a fit of illness, by which his wife was attacked, led him to the discovery of his theory respecting metallic irritation. The physician having prescribed for his wife soup made of boiled frogs, Galvani, who was an affectionate husband, prepared them himself; and having accidentally touched a frog after he had skinned it, he observed in it an involuntary motion, which induced him to make some experiments that conducted him to the discovery.

At Pavia, on the 1 th of February, of an inflammation in the urethra, Lazarus Spallanzani, of Reggio, the celebrated natural historian.

On the 18th of February, at Leipzic, John Hedwig, professor of botany, in the 68th year of his age. His researches respecting the cryptogamia class of plants will secure him immortal fame. His death will be a great loss to the General Literary Journal of Jena, to which he was a contributor, and which was indebted to him for many interesting communications.

On the 24th of February, at Göttingen, George Christopher

pher Lichtenberg, Efq. counfellor of ftate to his Britannic majefty, and public profeffor of philofophy in that univerfity. He was born at Ober-Ramftadt, near Darmftadt. On the 19th of February he read a public lecture, next day he was confined to bed, and on Sunday morning an inflammation of the breaft put a period to his exiftence. By this event the univerfity of Göttingen loft an excellent teacher, and Germany one of its moft ingenious writers, who, to profound knowledge in the moft fublime fciences, united an unexhauftible fund of original genius.

Not long ago at Paris, in the 64th year of his age, Charles Borda, an eminent mathematician, and one of the authors of the new French fyftem of weights and meafures. He was a *Lieutenant de Vaiffau du Roi* under the old French government, and with De la Crene and Pingré made a voyage to America, in order to afcertain the utility of certain inftruments for determining the latitude and longitude. The account of this voyage was publifhed under his infpection, with the title of *Voyage fait par ordre du Roi en* 1771 *et* 72, *en diverfes parties de l'Europe et de l'Amérique, pour vérifier l'utilité de plufieurs methodes et inftrumens fervant à determiner la latitude et la longitude tant du vaiffeau que des côtes, ifles et ecueils*, &c. par MM. Verdun de la Crene, Le Chev. de Borda, et Pingré, 1778, 2 vol. 4to. He was the author alfo of *Defcription et Ufage du Cercle de Reflexion*, 1787, 4to. and of feveral phyfical and mathematical memoirs in different journals. He has been fucceeded in the *Bureau des Longitudes* by C. Bougainville.

On the 7th of this month, at his houfe in Queen-fquare, Weftminfter, the Rev. Clayton Mordaunt Cracherode, A.M. Student of Chrift Church, Oxford, F.R.A.S. and one of the Truftees of the Britifh Mufeum.

Mr. Cracherode was eminent for his erudition, liberality of fentiment, and amiable manners. His learning he decorated with a fuperior knowledge of the fine arts; and he employed a confiderable part of a large revenue in making col-

lections

lections of what was best and most curious in literature and certain branches of the arts. His library is unrivalled in its kind; and his cabinet of prints, drawings and medals, is considered as among the most select and valuable in a country that possesses so many of them.—But to his extensive knowledge and pre-eminent taste must be added the more solid qualities of candour, of liberality, of benevolence; and he presented them all to the world, in which he lived at large, in the form of an accomplished Gentleman, heightened by the unaffected piety of a sincere Christian.

Mr. Cracherode has left a thousand pounds to Christ-Church, Oxford, where he was a student; and his very rich collection of medals, and immense library, to the British Museum.

Lately, at the age of 67, John Strange, Esq. of Portland-place, LL. D. member of the Royal and Antiquarian Societies, and of many of the learned and literary societies of Europe. Mr. Strange was many years British Resident at Venice, where, by his taste and indefatigable diligence, he formed one of the best collections of pictures, particularly of the Venetian school, now in England: his library also is most extensive and splendid. As a naturalist, antiquary, and general friend and promoter of the arts and sciences, his cabinet has always been considered as one of the choicest in the kingdom. By his will he has directed the whole to be sold; his pictures, under the direction of Mr. Wilson of the European Museum, by private contract, after being publicly exhibited; his books, by Messrs. Leigh and Sotheby; his prints, drawings, busts, coins, medals, bronzes and antiquities, by Mr. Christie; his cabinets of natural history, by Mr. King.—Thomas Gould, Esq. his brother-in-law, the Rev. Edward Nares, his nephew, and Mr. Alexander, his solicitor, are appointed trustees and executors.

THE

PHILOSOPHICAL MAGAZINE.

MAY 1799.

I. *Report on the Travels of* C. Olivier *and* C. Bruguiere, *undertaken by order of the French Government, through the Ottoman Empire, Egypt and Persia, during the Years* 1792, 93, 94, 95, 96 *and* 97. *Read in the Sitting of the National Institute, February* 14*th. By* C. Olivier.

In the year 1792 the provisional executive council, sensible of the advantages which might result to commerce, agriculture, natural history, geography, medicine, &c. by a tour through the Ottoman empire, Egypt and Persia; persuaded that these interesting countries had never been considered under a proper point of view, or had been considered only partially, and that we had still much to learn respecting them, made choice of C. Bruguiere and myself to accomplish that object.

After some delays, we at length sailed from Marseilles, in April 1793, in a neutral vessel, and, without touching any where by the way, arrived at Constantinople, after a pleasant voyage, on the 21st of May.

It would be difficult to express the different sensations excited in the traveller by the first view of that large city and its

its inhabitants. The mixture of trees, houſes and minarets; the canal of the Black Sea, the hills and valleys by which it is bordered, Scutari and the numberleſs villages ſituated on its ſhores, the ſea of Marmora with its iſlands, Mount Olympus covered with ſnow, the variegated and fertile fields of Aſia and Europe, all together preſent ſo many pictures which at once delight and aſtoniſh. One cannot help admiring the natural beauty of the environs of Conſtantinople, and reflecting at the ſame time on the happy ſituation of that large city, which can be ſo ſpeedily ſupplied with proviſions; which is ſo eaſy to be defended, and which enjoys the advantage of a port ſo ſafe, ſo commodious, and of ſuch an extent. But if we caſt our eyes a little farther, we behold the two ſhores of the entrance into the Black Sea, for the ſpace of ſeveral leagues, convulſed by ſubterranean fires. Different ſtrata of lava, decompoſed rocks, porphyry and granites of various colours, more or leſs altered, atteſt the flow and ſucceſſive action of a great volcano. If we aſcend a few leagues, we diſcover, for a vaſt extent, a mine of coal, which the Turks have not yet found means to work.

We remained ſix weeks in this capital of the Ottoman empire, waiting till the envoy extraordinary of the Republic ſhould receive from the miniſter orders reſpecting our miſſion and allowance; but the attention of government was at that time engaged with objects of more importance. Our letters remained unanſwered, and we ſhould have been thrown into great embarraſſment had not our preſſing wants been ſupplied by the envoy of the Republic.

After viewing this country, ſo intereſting in every reſpect, and making an ample collection of plants, birds, fiſhes, inſects, ſhells and minerals; and after ſending two packages of ſeeds at different times to the national garden of plants, we ſet out for the Dardanelles, by which means we had it in our power either to proceed to the Archipelago in the ſpring, or to return to Conſtantinople in order to direct our courſe towards the ſouthern ſhores of the Black Sea; to proceed

through

through Armenia, Georgia, Ghilan, or Chirvan, to the borders of the Caspian sea; afterwards to traverse Persia from north to south, and to return by the Persian Gulph, Bussora, Bagdad, Mesopotamia and Aleppo. As we did not, however, hear from government, and could receive only a part of our allowance, we confined ourselves to excursions to different places in the neighbourhood of the sea of Marmora, the channel of the Dardanelles, Troade, Tenedos, Scio, some parts of the coast of Natolia, Mycone and Naxia, from which we proceeded to Crete.

Agreeably to our instructions, we had transmitted to Constantinople, to be reared in the garden of the ambassador's palace, plants of a kind of apple-tree with oblong fruit of an excellent flavour, proper to be cultivated in any part of France, but more particularly in the southern departments; plants of three kinds of oak not found in our forests or gardens—one kind proper for ship-building—another *à grand cupule* known in commerce by the name of *avellonée*, which is the *quercus ægilops*; and lastly, that which furnishes the galls of the Levant: we added also several shrubs destined to enrich the national garden of plants.

Though several well informed Europeans have traversed this part of the Ottoman empire; though many of them have published interesting observations on the political relations of the Turks, their manners, usages, and religion; and though we have excellent works on the plants and ancient history of these countries, we, however, found that there s still an abundant harvest to be reaped, even in the best known part of natural history, that is to say, in regard to plants. But when we reflect that the reptiles, river fish, insects and terrestrial shells in those districts have not been observed by any traveller; that no one has made us acquainted with the riches which the Turks possess in mineralogy, mines of iron and copper, pozzolana, and coals at the very gates of the capital, marble of all kinds exceedingly abundant in the islands of the sea of Marmora and the Archipelago, agates, cornelians and chalcedonies in the fissures of the volcanic rocks, mines of alum and sulphur, mineral waters of every kind; in a word, if we recollect that no traveller has considered this country in regard to geology, that part of natural history so interesting, which by enabling us to observe the different strata of earth and stones, the direction and structure of mountains, and to compare the different fossils that one meets with, must necessarily conduct to a certain knowledge of the antiquity of our globe, of the laws to which it is subject, and of the different catastrophes it has experienced, and of which some faint light has been transmitted to us by the fabulous history of antiquity, will be readily persuaded that our observations, directed to these objects, cannot fail of being highly interesting.

We remained four months at Candia; and though two years had elapsed since our departure from Paris, we had received no intelligence from government. We were, therefore, of opinion, that it would be absolutely necessary for us to renounce our first plans; but as we were desirous of employing our time in the most useful manner possible, we resolved to proceed to Egypt, and to traverse that country so abundant in subjects of observation, and as interesting for the politician and statesman, as for the philosopher, naturalist and antiquarian.

The situation of the French in Egypt was extremely disagreeable: their commerce had been interrupted, and they were in a state of oppression at Cairo. Some of them had been maltreated by the government, and the consul of the Republic enjoyed no consideration. Our first care was to study the monstrous government of the Mamelouks, their military force and their manners; to make ourselves acquainted with the revenues of Egypt, the present state of its commerce, and that which it might be susceptible of under a just and enlightened government. We examined the ports of Alexandria, the road of Aboukir, the Delta, the course of the Nile, its periodical inundation, the canals which the negligence of the Mamelouks has suffered to be filled up, the monuments reared to gratify the pride of kings, and those which have been constructed in consequence of religious duties. We directed our view, at the same time, to the natural productions of Egypt, and those which might be introduced into it by cultivation; the fertility of its soil, and the diseases to which the inhabitants are exposed. We enquired into the cause of the periodical winds. In the last place we examined whether the plague, that malady so sudden and so terrible in its effects, has its source in Egypt, as some travellers have asserted, or whether it be there only casual and epidemic. Our harvest, in regard to natural history, has been very abundant: we had an opportunity of transmitting to the national garden of plants a third box of seeds from the Archipelago, Candia and Egypt.

On the 23d of March we received letters from the envoy extraordinary, by which he invited us to quit Egypt and to return to the shores of the Bosphorus; because the time was at length arrived for carrying into effect the plans we had formed. " Regions lying farther to the East," said he, " now invite you, and I wish to confer with you before you proceed thither."

Under the same cover there were two letters of C. Desforgues, minister of foreign affairs. One was a copy of that which the minister wrote to C. Descorches; in which he requested from him an estimate of the sums necessary to be expended, in order that we might properly discharge our mission. He authorised him to supply us with whatever sums might be requisite, to procure such guides and information as the nature of our mission required, and to obtain those documents which were indispensibly necessary for our researches and observations. He concluded his letter with the following words: " In all cases these two observers of nature will be subordinate to your commands; they will give you an account of all their operations, and at the end of each month you will transmit to me the result of their obſervations on the arts, ſciences, natural hiſtory, commerce, and political ſtate of the countries through which they paſs, in order that I may give a faithful repreſentation to the executive council, of their zeal, their labours, and their diſcoveries."—In the other, the miniſter informed us, that he had requeſted C. Deſcorches to give him an account of the ordinary expences to which we would be ſubjected. He concluded by deſiring us to tranſmit our ſubmiſſion in writing to C. Deſcorches, and to conform to the diſpoſitions contained in the letter which he had addreſſed to him.

We embraced the earlieſt opportunity of complying, both with the orders of the miniſter, and thoſe of the envoy. We tranſmitted our ſubmiſſion; and, having terminated our obſervations on Cairo and the neighbourhood, repaired, without delay, to Alexandria. We ſailed from that port on the 30th of April, and arrived at Conſtantinople after a navigation of forty-eight days. We had the pleaſure of touching at the iſles of Rhodes and Lero, which we had not before ſeen. The repairing of a leak in our veſſel obliged us to remain eight days at the former; and we were detained as long at the latter on account of the North winds.

During this interval C. Deſcorches had been ſucceeded by C. Verniac. We therefore delivered to the latter a ſketch of our operations, from the period of our arrival in the Levant; a ſtatement of the ſums we had received; and a minute memoir on the ſituation of the French in Egypt, the government of the Mamelouks, the productions and revenue of the country, the cultivation of the land, on its commerce, and laſtly on the improvements of which the country was ſuſceptible *. This memoir concluded with reflections excited

* The following extract from Norden's Travels, reſpecting a tradition in Egypt, that the country would be viſited by ſpies, who would report its ſtate, and at laſt bring a great number of Franks who would conquer it, may amuſe ſome of our readers, and by ſome will be thought perhaps not inapplicable to C. Olivier's miſſion, and the events that have followed it:

"January

cited by the order which C. Deſcorches had given to the conſul and French at Cairo, to repair proviſionally to Alexandria, and put themſelves under the protection of the port captain of the Grand Signior; and to wait there until more favourable circumſtances ſhould enable the conſul to reſume his functions at Cairo, and the merchants their commercial operations. We forwarded to the national garden of plants a fourth box of the ſeeds from Egypt, Rhodes, Lero, and the ſhores of the channel of the Dardanelles, as well as a live ichneumon which we had reared for four or five months.

Perſia, a prey to the horrors of civil war ſince the reigns of the latter Sophis (the family of the Sephevi), gave reaſon to hope for a flouriſhing kingdom under a monarch who had triumphed over all his rivals, and had deſtroyed each of them in ſucceſſion. The opportunity was then favourable

"January 4, 1738.—On this day (Saturday) the Daniſh traveller, Captain Norden, with his attendants, arrived at Deir, or Derri, the firſt large village or town in Nubia. The cacheff of that place, a notorious plunderer of all who fell in his power, conducted himſelf towards the travellers in ſo infamous a manner, as to oblige the captain to relinquiſh his deſign of proceeding further, and return to Cairo. When diſputing about ſome of the exorbitant demands of the cacheff, one of the company reminded him that they were under the protection of the Grand Signior. To which he anſwered in a paſſion; 'I laugh at the horns of the Grand Signior: I am here Grand Signior myſelf, and I will teach you to reſpect me as you ought. I know already what ſort of people you are. I have conſulted my cup; and I have found by it, that you are thoſe of whom one of our prophets has ſaid: That there would come Franks in diſguiſe, who, by little preſents, and by ſoothing and inſinuating behaviour, would paſs every where, examine the ſtate of the country, go afterwards to make a report of it, and bring at laſt a great number of other Franks, who would conquer the country, and exterminate all. But I will take care about that; and without further delay you muſt quit my bark.' After being plundered by him, in various ways, till the evening of the following Monday, the travellers thought themſelves very fortunate in being permitted to eſcape with their lives.—[*Dr. Templeman's Tranſlation of Norden's Travels, 8vo. edit.* 1757, *vol. ii. p.* 150.] Edit.

for travelling into the interior parts of this country, fo interefting in every point of view. C. Verniac allowed us the whole of our appointment, authorifed us to engage a dragoman, gave us a letter to the chief minifter of the king of Perfia, another to the pacha of Bagdad, and, at the fame time, various inftructions both verbally and in writing.

At the moment of our departure, the Porte had a defign of conftructing in the harbour of Conftantinople a bafon after the model of that of Toulon; and fome Armenian merchants wifhed to prevail on us to communicate to them a difcovery we had made of an excellent kind of pozzolana, by offering us the fum of 30,000 piaftres. As we were here under the orders of the Republic, we did not think ourfelves at liberty to enter into any treaty with Armenians, in regard to our difcoveries, until we had apprifed the envoy of the Republic. C. Verniac, who intended to get this bafon conftructed by French engineers, defired us to reject the offers of the Armenians, promifing to procure us a more ample recompence from the Porte; and he immediately fent the firft dragoman of the legation to the Turkifh government, to communicate our difcovery, and make an offer of our fervices. The Porte feemed to accept this offer with gratitude; and having requefted a note on the fubject, we embraced the earlieft opportunity of tranfmitting to it a memoir, in which we faid that we had difcovered pozzolana of an inferior quality near the channel of the Black Sea, in Prince's iflands, and various iflands of the Archipelago; and fome of a fuperior quality, or at leaft equal to that of Italy, in the ifland of Santorin. The memoir concluded with a few details refpecting the method of employing both.

The minifters of the Porte, when they received this memoir, informed the dragoman, that the Armenians had demanded for the difcovery 60,000 piaftres, though they had offered us only 30,000. They added, that they would never forget the fervice which we rendered to them, and that their gratitude would be boundlefs if we could effect what we promifed.

promised. On this subject we had two interviews with the Chelebi-Effendi; and that minister twice gave us reason to hope that the Porte would reward, in a manner worthy of itself, the important discovery we had communicated.

In the mean time we were just on the point of proceeding on our journey to Persia. The necessary preparations were already made, and we were looking out for a caravan going to Diarbekir, when the Porte required that we should repair to the isles of Santorin, Milo, and Argentiera, and transmit to it some bags of pozzolana, in order that previous experiments might be made. For this purpose it freighted a French vessel, and sent a chiaous to accompany us and bring back the specimens. We were obliged to touch at Metelin to receive from the captain pacha, then lying at anchor before that island, the necessary firmans.

The inhabitants of Santorin, alarmed at this discovery, and fearing that the Ottoman government would cause the earth to be dug up at their expence, and of course send Turkish officers into the island, immediately assembled to execute the Grand Signior's orders, and to devise means for warding off the blow with which they were threatened. They thought they could do nothing better than to send the primates to the Latin bishop at whose house we lodged, and to offer us a present if we would inform the Porte that we had discovered none of the above substance in the island. We, however, rejected the offer of these primates, and transmitted to Constantinople several bags filled with pozzolana of an excellent quality, which was in great abundance, and exceedingly easy to be dug up. We depended on C. Verniac for the promised recompence to which we thought ourselves entitled by the importance of the discovery, by rejecting the offers of the Armenians, and the trouble, dangers, and delay we had experienced.

The island of Metelin, almost entirely volcanic, is remarkable on account of its great fertility, its immense ports, and its warm mineral springs. Argentiera, known formerly under

under the name of Cimolus, is entirely volcanic. We remarked, with pleaſure, that the Cimolean earth, which it furniſhes in abundance, is produced by a ſlow and gradual decompoſition of the porphyries occaſioned by ſubterranean fires. I collected ſpecimens of that earth in all the ſtates through which it paſſes. This obſervation will be intereſting, no doubt, to mineralogiſts, and make them acquainted with the origin of a ſubſtance hitherto little known. The iſland of Milo is altogether volcanic. It preſents a vaſt port, on the borders of which is a ſpring of warm aluminous water; a very warm grotto, where feather alum is formed; a volcano ſtill burning, and a prodigious quantity of catacombs. The iſland of Santorin is remarkable for the changes effected in it by a volcano, and the ſinking down of a great part of the iſland; from which has reſulted a kind of port, more than two leagues in extent, and from the bottom of which three iſles have been thrown up at different known periods. The rupture occaſioned by the almoſt circular ſinking down of the iſland exhibits different ſtrata of volcanic ſubſtances, among which we obſerved ſeveral kinds of pozzolana. That which we ſent to Conſtantinople, and of which I have ſpecimens, may one day ſerve for ſuch maritime conſtructions as the French may think proper to make in Egypt, when they are once firmly eſtabliſhed in that country.

We touched a ſecond time at Rhodes, proceeded thence to Baruth, and afterwards to Sayd, with a view of going to Damaſcus to take advantage of the departure of a caravan for Bagdad, as we had been taught to expect; but, the caravan having departed a long time before, we were obliged to return and take the route to Aleppo. We were unwilling to quit the coaſt of Syria without paying at Tyre a tribute of admiration to which that city was ſo juſtly entitled.

As the road from Latakia to Aleppo is never ſafe, we waited ſome days for the departure of a caravan. During that time we tranſmitted to the national garden of plants

a fifth

a fifth box of feeds, from the iflands we had vifited, and the coafts of Syria. On our arrival at Aleppo we employed ourfelves in examining the fituation of the French in that city. We collected information refpecting the commerce carried on by the Europeans with the inhabitants, and fent to C. Verniac a memoir on that fubject. We alfo made various obfervations in regard to natural hiftory and geology. We procured feveral birds, and a few quadrupeds: after which we fet out, towards the end of winter, in company with a caravan; and, paffing through Orfa, Merdin, Nefbin, and Mofu!, arrived at Bagdad without any accident.

(To be concluded in the next Number.)

II. *Procefs of making Attar, or Effential Oil of Rofes. By Lieut. Col.* POLIER. *From the* Afiatic Refearches.

THE attar is obtained from the rofes by fimple diftillation, and the following is the mode in which I have made it.

A quantity of frefh rofes, for example forty pounds, are put in a ftill with fixty pounds of water, the rofes being left as they are with their calyxes, but with the ftems cut clofe. The mafs is then well mixed together with the hands, and a gentle fire is made under the ftill: when the water begins to grow hot, and fumes to rife, the cap of the ftill is put on, and the pipe fixed; the chinks are then well luted with pafte, and cold water put on the refrigeratory at top: the receiver is alfo adapted at the end of the pipe; and the fire is continued under the ftill, neither too violent, nor too weak. When the impregnated water begins to come over, and the ftill is very hot, the fire is leffened by gentle degrees, and the diftillation continued till thirty pounds of water are come over, which is generally done in about four or five hours: this rofe-water is to be poured again on a frefh quantity (forty pounds) of rofes, and from fifteen to twenty pounds of water

water are to be drawn by diſtillation, following the ſame proceſs as before. The roſe-water thus made and cohobated, will be found, if the roſes were good and freſh, and the diſtillation carefully performed, highly ſcented with the roſes. It is then poured into pans either of earthen ware or tinned metal, and left expoſed to the freſh air for the night. The attar, or eſſence, will be found in the morning congealed, and ſwimming on the top of the water; this is to be carefully ſeparated and collected, either with a thin ſhell or a ſkimmer, and poured into a phial. When a certain quantity has thus been obtained, the water and fæces muſt be ſeparated from the clear eſſence, which, with reſpect to the firſt, will not be difficult to do, as the eſſence congeals with a ſlight cold, and the water may then be made to run off. If, after that, the eſſence is kept fluid by heat, the fæces will ſubſide, and may be ſeparated; but if the operation has been neatly performed, theſe will be little or none. The fæces are as highly perfumed as the eſſence, and muſt be kept. After as much of the eſſence has been ſkimmed from the roſe-water as could be, the remaining water ſhould be uſed for freſh diſtillations, inſtead of common water, at leaſt as far as it will go.

The above is the whole proceſs of making genuine attar of roſes. But as the roſes of this country give but a very ſmall quantity of eſſence, and it is in high eſteem, various ways have been thought of to augment the quantity, though at the expence of the quality. In this country, it is uſual to add to the roſes, when put in the ſtill, a quantity of ſandal-wood raſpings, ſome more, ſome leſs, (from one to five tolahs, or half ounces). The ſandal contains a deal of eſſential oil, which comes over freely in the common diſtillation; and, mixing with the roſe-water and eſſence, becomes ſtrongly impregnated with their perfume: the impoſition however cannot be concealed; the eſſential oil of ſandal will not congeal in common cold, and its ſmell cannot be kept under,

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but will be apparent and predominate in fpite of every art. In Cafhemire they feldom ufe fandal to adulterate the attar; but I have been informed, to increafe the quantity, they diftill with the rofes a fweet-fcented grafs, which does not communicate any unpleafant fcent, and gives the attar a clear high green colour: this effence alfo does not congeal in a flight cold, as that of rofes. Many other ways of adulteration have been practifed, but all fo grofs and palpable that I fhall fay nothing of them.

The quantity of effential oil to be obtained from the rofes is very precarious and uncertain, as it depends not only on the fkill of the diftiller, but alfo on the quality of the rofes and the favourablenefs of the feafon: even in Europe, where the chemifts are fo perfect in their bufinefs, fome, as Tachenius, obtained only half an ounce of oil from one hundred pounds of rofes.—Homberg obtained one ounce from the fame quantity; and Hoffman above two ounces.—The rofes in thofe inftances were ftripped of their calyxes, and only the leaves ufed. In this country nothing like either can be had; and to obtain four mafhas (about one drachm and half) from eighty pounds, which, deducting the calyxes, comes to fomething lefs than three drachms per hundred pounds of rofe-leaves, the feafon muft be very favourable, and the operation carefully performed.

In the year 1787 I had only fixteen tolahs, or about eight ounces of attar from fifty-four maunds, twenty-three feers (4366lb.) of rofes produced from a field of thirty-three biggahs, or eleven Englifh acres, which comes to about two drachms per one hundred pounds.

The colour of the attar of rofes is no criterion of its goodnefs, quality, or country. I have had, this year, attar of a fine emerald green, of a bright yellow, and of a reddifh hue, from the fame ground, and obtained by the fame procefs, only of rofes collected at different days.

The calyxes do not in any fhape diminifh the quality of the attar, nor impart any green colour to it, though perhaps

haps they may augment the quantity: but the trouble neceſſary to ſtrip them muſt, and ought to, prevent its been ever put in practice.

III. *On Primary Ores of Iron. By Mr.* David Mushet, *of the Clyde Iron Works. Communicated by the Author.*

PRIMARY ores of iron are ſo named in contradiſtinction to ores which appear, like iron-ſtones, to have been formed by a ſecondary agency. Their varieties are ſtill more numerous than thoſe of iron-ſtones; poſſeſſing various characteriſtic features, which amply diſtinguiſh them from each other, either in their inherent properties and effects, or in the manner of their foſſil diſpoſition. Some are obedient to the magnet, others not. This property is by no means dependent upon the quantity of iron exiſting in the ore: the ore from the iſland of Elba, ſome of which yields 70 to 80 per cent. of iron, is ſlightly obedient to the magnet: the fine hæmatites and kidney of the Cumberland ore, which yield from 64 to 70 per cent. are not, in their native ſtate, in the leaſt degree magnetic; while many of the Daniſh and Norwegian ores, containing from 18 to 30 per cent. are magnetic in a great degree. I have formerly mentioned, that where the magnetic property was inherent, it was more a proof of the exiſtence of iron, than a criterion whereby to judge of the probable quantity of metal in the ore.

The colours which primary ores of iron exhibit are alſo very various. The beautiful cryſtalliſed fractures of the Elba ſpecimens, the priſmatic colours they exhibit, the coloured oxyde depoſited in flowers upon their ſurface, and the general appearance which they have of fuſion, ſtrongly lead to a concluſion that fire has here been the immediate agent in the production of ſuch variegated forms. This concluſion is ſtill more forcibly impreſſed, after minutely examining and comparing with them thoſe very perfect cryſtals which are found amongſt

amongſt the Cumberland ores. Theſe at once convey the idea of the agency of water in their formation: if the internal cavities of ſome of the pieces are examined, the proofs multiply and become irrefragable. The chaſms in which the cryſtals are found, and always formed, diſplay the proceſs of cryſtallization in all its various ſtages. Cryſtals are found in finiſh and form proportioned to the ſtage of the operation: ſome imperfect, and of a clayey conſiſtency and colour; others in a more finiſhed ſtate, hard, but as yet unpoliſhed or diaphanous: ſome are encircled in a ſlimy membrane, which, when diſplaced, diſplays the cryſtals more or leſs tranſparent as the operation has been more or leſs perfect. I have found cavities in this ore quite filled with water, which in this ſtate had been tranſported ſome hundred miles; the ſides and bottoms of ſuch chaſms always abounding with a ſoft mud compoſed of the fineſt fragments of ſilex, free from every touch of aſperity. Again, cryſtals are found in this ore, which poſſeſs various degrees of pellucidity; ſome of them very white, yet dull; abſorbing light, yet tranſmitting little. Others are as clear and tranſparent as the pureſt water; their angles frequently decompoſing light with all the vivid effects of the priſm. Other varieties are leſs diaphanous, but poſſeſs various tinges of colour, and increaſe in opacity in proportion as the colouring matter is preſent in the cryſtal. Some poſſeſs a garnet colour more or leſs intenſe, and moſt of them tranſmit leſs or more light.

There is another variety of cryſtals among the Cumberland ore, exhibiting a green colour, which is owing to the preſence of an acid. This, like the garnet coloured cryſtal, tranſmits light in a greater or leſſer degree in proportion to the quantity of iron preſent. There are alſo various priſmatic cryſtals in this ore, of a ſmall ſize, which owe their ſplendid and variegated luſtre to ſulphur, and which are eaſily tarniſhed by the application of heat. Specimens alſo of cryſtallized iron ore, in the form of razor blades, containing oxygen and carbon, are not uncommon: theſe reſemble more the Elba ore

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than any other variety; yet, the ſtate of the carbon ſo much reſembling foſſile plumbago, ſo unlike the carbon which the Elba ſpecimens afford, and ſo widely different from that obtained by fuſion, together with the ſmallneſs and regularity of the cryſtals, their luſtre and finiſh conſtitute a wide difference between theſe two ores.

The fine red oxyde which ſo much reſembles cinnabar, and which is found in abundance upon the Elba iron ore, appears to me to be an oxyde of iron depoſited by the decompoſition of ſulphat of iron. Thus far I can ſay, that a powder exactly ſimilar was depoſited upon the ſurface of ſome iron-ſtones expoſed to a high temperature, in which I had aſcertained the preſence of the ſulphuric acid. The various ſhades of colour which appear upon the Elban ore, exactly reſemble thoſe which may be paſſed upon ore, iron, or ſteel, by expoſing them under certain degrees of heat to the action of atmoſpheric air. Its fracture is moſt evidently vitrified, and exactly reſembles iron fully combined with oxygen, afterwards reduced by fuſion to an opaque and very ponderous glaſs. Like the Elban ore, ſuch vitrifications, when broken, diſplay a perfect ſtate of cryſtallization.

I have even obtained ſpecimens of this ponderous lava poſſeſſing a variety and richneſs of colouring, equal to many of the Elban ſpecimens.

Though the agency of water will more readily explain the ſtructure, cryſtallization and depoſition of foſſils in general, yet there are circumſtances which moſt forcibly claim an exception. The Elba ore, in my opinion, is one: I conceive it to be iron oxydated in fuſion by the combination of a quantity of oxygen, from 18 to 24 per cent. incluſive of a ſmall portion of carbon, to which, either at the time, or by a ſubſequent proceſs, ſome volatile mixtures have been added. In a more proper place I ſhall minutely enter into the nature and analyſis of this beautiful ore of iron. I ſhall only here exhibit ſome ſimple reſults obtained from it when comparing it with other ores of iron.

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The form and appearance of the maſs of this ore much reſembles the exceſſively ſaturated ſpecimens of crude iron and plumbago, deſcribed in my paper upon the principles of iron and ſteel, with an allowance in the former for its long expoſure to the tarniſhing effects of water and other elements: the agency of theſe has conferred a variety of colours in flowers, though the principal colouring of the ore ſeems to have been the effects of oxygen combined with the iron at certain degrees of heat: in its raw ſtate the magnet has little power over it. Of this ore pulveriſed (which poſſeſſed a fine reddiſh brown colour, interſperſed with ſhining ſpecula of magnetic iron ore, reſembling plumbago produced in the ſmelting furnace), I threw into an iron veſſel heated to redneſs 80 grains: a gas was diſengaged, which, from its ſmell, I concluded was carbonic acid gas, for I had not at hand a proper apparatus or lime-water to try it with: the ore deepened during ten minutes expoſure, without changing the ſplendor of the ſmall ſpecula; when cooled, it was found to have loſt 2 grains = 2·25 per cent.

I next introduced into a cloſe veſſel, in ſmall pieces, 315 grains, and expoſed them to torrefaction for four hours in a bright red heat: the reſidue weighed 282; ſo that there were loſt of carbonic acid, and perhaps a little water, 33 grains = 10·7 per cent. The fine red, brown, and purple colours, were now totally annihilated; a ſlightly coloured powder was attached to the ſtopper of the veſſel; the ore was now of a dull blueiſh colour, much frittered, granulated, but not pulverulent: the magnet in this ſtate poſſeſſed a conſiderable degree of influence over it, but by no means in proportion to the quantity of iron which it contained—not even equal to what it has on common iron-ſtones: from this circumſtance I inferred, that a conſiderable quantity of oxygen ſtill remained fixed with the metal. In order to aſcertain this, I introduced the laſt product, weighing 282 grains, into a cloſe veſſel, mixed with charcoal duſt: the mixture was expoſed for nearly ten hours to a bright red heat; the ore being then ſeparated

parated from the charcoal, waſhed and dried, weighed 222·5, the charcoal having taken up 59·5 grains = 21 per cent.

In this ſtate the ore had loſt all its colour, and had aſſumed a whitiſh limey tinge; had increaſed in bulk, and become fritteréd, yet poſſeſſing a conſiderable degree of continuity: when the ſmalleſt degree of friction was applied, the metal brightened, and ſhewed a beautiful diſengaged ſtate of malleable iron; the pieces eaſily connected under a welding heat, and received with facility impreſſions from the hammer; it now adhered in great abundance to the magnet. The ſmall portion of lime, nearly equal to two parts, which was ſtill interſperſed with it, effervesced in acids; but the iron remained without exciting agitation. The practical analyſis of this ſpecimen of the Elba ore may, for the preſent, be thus ſtated:

Water, carbonic acid, and other volatile mixtures, driven off by torrefaction - -	10·7
Oxygen (taken up by the charcoal) -	21·2
Lime - - -	2
Iron - - - -	66·1
	100 parts.

The ſpecific gravities of the various ſtates of this ore are as follows:—In the raw ſtate, 4·317—Torrefied, 4·000—De-oxygenated, malleable, much frittered, 2·460.

In the ſubſequent part of this paper, I ſhall confine myſelf chiefly to thoſe primary ores uſed in Britain for the production of crude iron. The effects produced by ſuch ores, when fuſed alone, are only to be learned in this country, at thoſe iron-works where the charcoal of wood is uſed. The number of charcoal furnaces however are decreaſing; and thoſe at preſent uſed as ſuch, are not ſupplied with wood for one-third of the year. Theſe ores are, in the charcoal furnace, capable of producing crude iron of all the various degrees of carbonation. Since the invention of coak pig-iron, the proprietors of theſe furnaces have confined their manu-

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facture to the forge pig, or oxygenated crude iron, part of which is ufed to make a fine quality of bar-iron for the purpofe of manufacturing into wire: for this end fome of the manufacturers prefer carbonated iron, from which to fabricate their bars, in order that a great fhare of ductility, elafticity and ftrength may conjointly be united. Britifh bar-iron, thus manufactured, far exceeds the fineft foreign marks, in its aftonifhing ductility in the wire-drawer's gauge.

When primary ores of iron are introduced into the pit-coal blaft furnace, forming by weight a confiderable proportion of the mixture, with the ufual proportion of coaks, the refult is always oxygenated crude iron, unfit for any purpofe but the forge manufacture. Experience, therefore, has taught the fmelter to ufe them in fmall quantities, proportioned to the meafure of iron-ftone applied at each charge of materials. Some have renounced the ufe of Cumberland and Lancafhire ores, as being incompatible with the exiftence of good melting pig-iron; and the advocating for or againft their ufe is at prefent a matter of local opinion. So much is, however, decided regarding them, that primary ores of iron in any proportion will, when improperly applied, produce oxygenated crude iron; that iron-ftone, properly proportioned with coaks, affords the fineft quality of crude iron; and, in the iron trade, it is ftill a defideratum, whether Cumberland and Lancafhire ores, when fmelted with pit-coal, will afford in the large way a quality of pig-iron equal to that prefently made from iron-ftone. On this interefting fubject I fhall make a few obfervations. I deem it interefting, fince, in many places on the coaft of Scotland, coal is to be found in great quantity, where as yet a fufficient quantity of iron-ftone has not been difcovered, or which from appearances likely never may: in fuch fituations, favoured by a ready communication, either to import materials, or to vend raw or manufactured products, the Cumberland and Lancafhire ores might be purchafed and ufed with great econo-

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my, provided the great end could be anſwered of obtaining from them crude iron of all the various degrees of carbonation.

Theſe ores, either in a raw or *calcined* ſtate, being much richer in iron—nearly double—than the average maſs of iron-ſtones, are in the blaſt furnace more fuſible, from their ſuperior richneſs; they deſcend ſo rapidly to the bottom of the furnace, through the ſtrata of ignited coaks, that time is not given for imbibing the carbonic principle; part of the iron is ſeparated highly oxygenated, and part of it runs off precipitated in oxygen, and united with the ſcoria or fuſed earths. When this is found to be the caſe, and which is eaſily known by the fracture, weight, and blackneſs of the lava—were the manufacturers to add a farther proportion of fuel to take up the remaining oxygen, then the whole, or nearly the whole of the metal would be revived; ſtill it would poſſeſs a white fracture. Were the Cumberland and Lancaſhire ores ſolely uſed with pit-coal, were they deprived of their iron, and again that iron revived, though poſſeſſed of a highly oxygenated fracture, the great object would be half effected; for it is obvious, that in this caſe the furnace, and the quality of iron, are in the ſame ſtate with a blaſt furnace, affording a ſimilar quality of metal where iron-ſtone and pit-coal coaks only are uſed. In the latter caſe a ſmall additional portion of fuel, per charge, enables the metal to take up a part of the carbon afforded by the fuel: the fracture of the metal is, by this combination, or mixture, changed from white to grey blue; its aſſumption of this colour is in proportion to the extra quantity of fuel. From this fact, and from the parity of ſituation, I conclude that by a ſimilar treatment—the additional fuel being always proportioned to the weight of metal in the ore—the metal of ſuch ores might be revived ſufficiently carbonated for any purpoſe; though, I queſtion not, poſſeſſed of peculiar characteriſtic properties, which would diſtinguiſh this metal, in a greater or leſs degree, from that obtained from iron-ſtones treated in the ſame manner.

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Accuftomed to apply the ores by weight, a determinate quantity is frequently introduced into the furnace without adverting to its fuperior richnefs in iron, and the confequent extra proportion of fuel neceffary to take up its relative proportion of oxygen. The nature and confequences of this will be better underftood by the following example; firft premifing, that the quantity of oxygen—which is the great evil to be got rid of—exifts in a juft proportion to the quantity of iron. Suppofe then a blaft or fmelting furnace, burdened in the following manner as to coaks and iron-ftone: Coaks 400 lb.—Torrefied iron-ftone of various qualities 420 = 820: let this quantity be fuppofed to yield in the blaft furnace 40 per cent. then each charge will yield 168 lb. Let it alfo be fuppofed that this proportion of materials afforded fuper-carbonated iron; in this cafe there was prefent, not only a fufficient quantity of carbon to take up the oxygen contained in the ore, but fuch an abundance as to unite with the iron and to form plumbago. Should it be wifhed to reduce the quality, or to increafe the quantity of the pig-iron, by rendering it lefs carbonated; and fhould this be effected by adding to the above mixture a fmall box of Cumberland ore containing 60 lb., then a portion of iron, with its accompanying oxygen, (fuppofing the ore to yield in the blaft furnace 55 per cent.) would be thrown into the furnace equal to 33 lbs.; and the total produce of iron, per charge, would be 168+33 = 201 pounds, making a fum nearly equal to $\frac{1}{5}$ of the original quantity. This portion would of courfe require $\frac{1}{5}$ of additional fuel to preferve the original quality of the metal: it is even prefumable that the proportion of coaks increafes in a greater ratio, owing to the fpeedy defcent of the ore through the furnace: this increafe may be fairly eftimated as 5 to 8. The quantity of fuel being now too little to take up all the oxygen, part of the metal remains unrevived, and flows out, minutely divided, and interfperfed through the fcoria, in the ftate of an oxyde; the feparated metal, deprived of its original portion of char-

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coal, iſſues from the furnace highly oxygenated—a number of globules deflagrating ſo ſoon as it comes in contact with the air.

If, in order to correct the quality of the iron, a portion of the iron-ſtone is taken off = 1 box, or 60 lb. let the produce of this weight be eſtimated at 40 per cent. then the quantity of metal taken from the total 201, will be equal to 24, leaving for metal produced at each charge 177 lbs. inſtead of 168, as in the former caſe when the iron was ſuper-carbonated.—Additional quantity of metal = 9 lbs.

Quantity of concrete oxygen, reckoned at 22 per cent. nearly equal to 2 pounds weight.

Small as this quantity may appear to be, yet, on many occaſions, a furnace will not admit of the addition without altering the quality of its iron from the one extreme to the other. The manufacturer, therefore, finding his operation with ores ſo ſubtle and precarious, frequently abandons their uſe, in the firm belief that their application, in quantity, is incompatible with the exiſtence of good melting pig-iron; whereas, had the ore received a proportion of fuel adequate to its ſuperior richneſs, it is at leaſt queſtionable whether the exact ſame conſequences would have been entailed: even in the caſe of iron-ſtones, the manufacturer ought to conſider the quantity of iron contained in the ore, as alſo the nature of the various mixtures, in order to enſure to himſelf a produce of carbonated crude iron.

There are two ways which would moſt likely be attended with the happieſt effects in producing melting pig-iron from primary ores of iron with pit-coal, advantageous to individuals, and to the improvement of the buſineſs in general: the one, by a proceſs ſimilar in its principles of preparation to that at preſent practiſed for iron-ſtones; the other, by de-oxygenating the ore before it is introduced into the blaſt furnace. To enſure ſucceſs in the former of theſe operations, the following requiſites would be neceſſary.

1ſt. A narrow conſtructed furnace, of an unuſual height, in defcending through which, the ore, previous to fufion, would be expofed to a long cementation in contact with the coal; by which means the carbonaceous or fufible principle would be conveyed to the metal in quantity, and its quality thus conftituted previous to feparation.

2nd. The column of air neceffary in this cafe would require to be cool, denfe, and quickly impelled; the diameter of the difcharging pipe not to exceed $2\frac{1}{4}$ inches, but the column of blaft able to fupport 6, $6\frac{1}{2}$, or 7 inches of mercury.

3rd. In the application of the ore itfelf great attention ought to be given to the quantity of iron contained, as alfo to the quantity of oxygen combined with it, in order that a quantity of coaks might be applied adequate to what a fimilar portion of iron would require in ufing iron-ftone.

4th. The ore fhould be dried in a red heat, that what portion of water and fulphur it contained might gently be diffipated; care to be taken, however, to prevent a high degree of heat, that a greater quantity of oxygen from the atmofphere might not be united to it.

5th. It would be highly proper to reduce the ore to fmall pieces: this would not only greatly facilitate the efcape of the water and fulphur by diminifhing the points of contact, but alfo, by expofing a larger furface, enable the ore in the fmelting furnace to take up the coally principle with greater facility; the pieces not to exceed $\frac{1}{2}$ or $\frac{3}{4}$ of an inch in their thinneft diameters.

6th. The earthy mixtures of ores being chiefly filiceous, the application of pure calcareous earth as a flux or folvent would be requifite; and, according to exiftent circumftances, a lime-ftone, containing fine clay, flightly coloured by the prefence of the oxyd of iron, might be ufed: the bulk of the pieces of lime-ftone ought alfo to be a matter of attention, and fhould not greatly exceed the ore in fize.

In the end, fhould an affociation of thefe requifites produce the defired effect, and crude iron of all the various degrees of carbonation be obtained from primary ores of

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iron, it would render many ſituations in this country eligible for iron-works, which are at preſent only ſo on account of the immenſe profuſion of coal with which they abound; it would call into profitable exiſtence the iron contained in theſe vaſt and extenſive mines of Cumberland and Lancaſhire; confer ſpirit and activity on the manufacturer and the landed proprietor, in a general ſearch after ſo profitable and uſeful a mineral; and would tend to throw new and ample light upon many valuable ores of various natures, which at this time lie dormant, unexplored, and unappreciated.

The ſecond method likely to ſucceed in fabricating melting pig-iron from primary ores would be to ſubject them to de-oxygenation in the moſt economical way; not ſeverely, ſo as to change them into malleable iron, but in a manner which would ſtill render them ſufficiently fuſible. The de-privation of oxygen in this manner, would enable the carbonaceous principle to take immediate effect, by penetrating the ore, and conſtituting real fuſibility: it is even probable that the quantity of fuel uſed to effect this, in ſuch ſimple conſtructed furnaces as might be found anſwerable, would afterwards be ſaved in the ſmelting furnace, and the ore rendered equally cheap in this ſtate as when raw—beſides the great point in obtaining the wiſhed for quality of iron.

The coaly matter requiſite to ſtratify the ore—previous to de-oxygenation—would be the duſt afforded by the coals in the preſent mode of coaking; and which, from the tender nature of the coal, exiſts, at ſome works, in great quantities; it is of no real value, and, by paſſing it through ſieves to render it of an equality of ſize, it might be uſed to imbed the ore without any other preparation. Such matter as this is capable of protecting the ore for a much longer time than would be requiſite in this operation: charcoal-duſt, made from pit-coal, is capable of withſtanding a heat equally violent as charcoal-duſt from wood, without being ſooner conſumed; it is even leſs liable to be deſtroyed when at

any

any time in contact with external air, either in the procefs of cementation for fteel, or in the de-oxygenation of iron-ores. Iron-ores thus ftratified, expofed to a ftate of complete ignition, would in 8 or 10 hours nearly part with the whole amount of mixtures, including oxygen, with which they were combined; the ore would be found penetrated with a confiderable portion of carbon, and the metal exifting in a ftate nearly difengaged. Their tendency, however, would much depend upon the various mixtures which compofed the individual ores; their lofs of weight, their properties and appearance, alfo depending upon fimilar circumftances with thofe explained in the preparation of iron-ftone in a former paper.

The varieties of the primary ores of iron found in this country are much limited, and chiefly poffefs the fame external characteriftic forms—at leaft thofe which have come within my knowledge—that of the ifland of Iflay excepted. Cumberland and Lancafhire feem to be the two great depofits for this mineral. The ore of the former is found in large maffes, fplinty, and globulated, confifting of various kidney forms and hæmatites, ftriated and fmooth, of blueifh and reddifh colours. The kidneys are frequently large, compofed of fucceffive layers encrufting a nucleus of coarfer ore. The fplinty pieces are of a light blueifh colour, and frequently afford the moft beautiful fpecimens of various cryftals, principally of a whitifh colour, of a chalky, and fometimes of a pellucid appearance; alfo garnet, more or lefs intenfe, and green. The moft common fhapes are pentagonal and hexagonal pyramids, with truncated bafes. Some of thefe I have found meafure 1 inch at the bafe: from this uncommon fize, down to the moft minute forms imaginable, the fame figures are found poffeffing purity, tranfparency, and finifh in the higheft degree: thefe claffes are of a whitifh water colour, more or lefs pellucid. Garnet coloured cryftals are found of the fame fhape, but of a very fmall

fmall fize, none of them meafuring more than $\frac{1}{20}$ of an inch upon the bafe.

The various fhades of garnet, yellow, and green coloured cryftals, when found of a large fize, have generally affumed the form of a prifm, a cube, or a parallelopipedon with flattened edges: none of thefe, however, poffefs the tranfparency of the pure quartzofe cryftal. The whole of thefe forms are found in chafms in the large maffes of fplinty ore: when the cavity is broken up, the groups of cryftals are found occupying all its fides, and projecting their tops to each other. Not unfrequently clufters of cryftals are found imbedded in a thin ftratum of beautifully cryftallifed prifmatic iron-ore, obedient to the magnet, and poffeffed of the moft fplendid dazzling colours.

The Lancafhire ore is compofed of fmaller maffes, fofter, and of a more greafy appearance; there are, however, in it all the former variety of cryftals, though of a fmaller fize. The quality of this ore is alfo much preferred in the blaft furnace, whether in the procefs with pit-coal coaks, or with the charcoal of wood. This partiality is owing to the mixtures in it being more favourable to the exiftence of carbon in the blaft furnace: clay, and not unfrequently calcareous cryftals, are found in this ore; whereas the earthy mixture of the Cumberland ore is chiefly filiceous, with a fmall portion of fulphur. Both of thefe ores, in the kidney variety, contain fine fpecimens of foffile plumbago.

In feveral places in Scotland iron ores have been difcovered refembling in point of appearance thofe of Cumberland and Lancafhire: fome individual pieces as rich in iron, but the average quality, as to contents in iron, inferior. The quantity hitherto found has been fo fmall, and its locality fo infulated, that it has never been, to the manufacturer, an object of attention, nor of farther fearch to the proprietor. In the Weft Highlands fome tranfient veins have been found, but their irregularity of difpofition has

hitherto

hitherto prevented their ſource, or principal maſs, from being explored.

A vein, which indicated a large field of ſupply, was ſome years ago traced in the neighbourhood of Muirkirk iron-works, and its courſe followed for ſeveral miles. The kidney pieces of this ore are fully as rich and ponderous as thoſe of the Cumberland vein.

Saliſbury Craggs, in the neighbourhood of Edinburgh, afford alſo ſome very good ſpecimens of an irregular vein, which ſtill remains untraced; apparently the ſame ore is found on an eſtate belonging to the family of Dundonald, called La Mancha, 10 miles ſouth of Edinburgh; the lands of Cranſton alſo afford a ſimilar ore: the quality of the ore, in both of theſe places, may be reckoned upon the average to yield 42 per cent. of iron.

I have ſeen ſome very fine ſpecimens of iron-ore picked up in different parts of Fifeſhire, where no vein could poſſibly be diſcovered.

The fineſt Scotch ore I have ſeen, and which poſſeſſes mixtures congenial to the exiſtence of carbon in the blaſt furnace, is found in the Ochil-hills, not above two miles from the Devon iron-works. This ore is ſoft, looſely ſtriated, of a reddiſh colour, not very ponderous, but poſſeſſing a ſuperior quantity of iron.

The iron ore of the iſland of Iſlay is found regularly ſtratified, and reſembles, in point of depoſition, the Norwegian and Daniſh ores. The ſtrata are almoſt vertical, and are found imbedded in a looſe ochreous earth ſurrounded with ſoil: the fracture of this ore partakes of the nature of the imbedding earth; it abounds with ſhining ſpecula reſembling ſilex, but which, upon cloſer examination, prove to be plates of ſlightly magnetic iron-ore.

Having thus ſhortly enumerated ſome of various indications of the exiſtence of iron-ore in Britain, I ſhall ſubjoin the treatment of two of them widely different in their foſſile depoſition, their appearance, and their component parts; theſe

these shall be, the ore of the island of Islay, and the Cumberland iron-ore.

Of the former I pulverised 872 grs. which I threw into an iron vessel of a red heat. In $1\frac{1}{2}$ minutes, during which time no sensible smell was disengaged, the powder assumed a complete change of colour, and lost in weight 12 grs. The ore was again returned into the furnace, and exposed to a bright red heat for 5 minutes, in which time it lost farther 28 grs. —in all 40 grs. = 4·58 per cent.

I next reduced to small pieces 2700 grs. of this ore, and subjected them to a high heat for 8 hours, partially exposed to air, in which time 314 grs. of volatile mixtures were driven off, equal to 11·2 per cent.

The ore had now assumed a reddish blue colour; had become friable, and much divided; it parted in small granulated masses, like the fragments of quartz, but was considerably magnetic. The fracture was rough, full of asperities; it did not effervesce with acids, nor had it acquired any sensible increase of weight; when pulverised, the shining specula were most conspicuous, and very magnetic. Some of their surfaces, by avoiding the one pole of the magnet, and embracing the other, led me to suppose they had polarity. In order to de-oxygenate this ore, I introduced 2040 grs. in small pieces, mixed with charcoal, into an iron test luted with clay, and exposed the mixture to a high red heat for ten hours: the ore then separated from the charcoal, and weighed, was found to have lost, of volatile mixtures and oxygen, 456 grs. = 22·3 per cent.; from which deducting 11·2 as the quantity of volatile mixtures, being the quantity lost by simple torrefaction as stated above, there remains 11·1 per cent. for oxygen taken up by the charcoal.

In this state the ore had assumed a blueish colour; had become bulky and pulverulent, without exhibiting the smallest sign of malleability: it was, however, so completely de-oxygenated, and the metal so much revived, as to deflagrate with the rapidity of iron filings.

I next

I next expofed of this ore in fmall piees to a fimilar temperature, in an open veffel, - - 1804·2 grs.
After eight hours the fragments weighed - 2260

Gained in weight, by the combination of oxygen, 455·8 grs. equal to 25·2 per cent. of de-oxygenated ore, and to 19·6 of raw ore.

The magnetic virtue fo eminently manifefted in this ore was now totally loft, and the individual pieces had acquired a fenfible increafe of weight. From this ore I obtained, by fufion, a button of oxygenated crude iron, equal

to - - - -	56·5
Oxygen taken up, as above -	11·1
Water of cryftallifation - -	11·2
Earths, chiefly filex and clay, -	12·2
	100 parts.

The fpecific gravity of this fpecimen I found to be—in a raw ftate, 3·370; de-oxygenated, 3·060; oxydated and combined with 25·2 per cent. oxygen, 4·000.

Of the many experiments I have made upon the Cumberland iron-ore, the following, at the prefent time, may ferve as a comparative treatment with others. Of this ore, pulverifed, I threw into a red hot veffel - 218·5 grs.
Inftantly a blue flame arofe, and hovered nearly half a minute upon the furface of the powder: the fmell was fulphureous, penetrating, and ftrong: the powder, after 5 minutes, was taken out, and weighed - - 212·5

Loft of water and fulphuric acid - - 6 grs.
The colour was confiderably deepened, and the mafs had acquired a minute portion of magnetic obedience.

I next torrefied, of this ore, in an open teft, - 2086 grs.
After a bright heat of eight hours, the refidue weighed - - - - 1961

Total lofs of water and fulphur - 125 grs.

 In

In order to de-oxygenate this ore, I introduced, mixed with charcoal, into an open veffel, - 2894 grs.
This mixture was expofed, under a high heat, for ten hours: when the ore was feparated from the charcoal, it weighed - - 2069

Total lofs of volatile mixtures = 28·5 per cent. 825 grs.

In this fhort time the whole mafs had become malleable, highly polifhed, and was finely converted: when heated, the pieces welded together, and were eafily drawn into fmall rods of good malleable iron.

In another experiment I expofed, of the de-oxygenated ore, to a ftill higher degree of heat than the former, 1841·5 grs.
The mafs, when cool, weighed - - 2489

Gained in weight, by the combination of oxygen, 647·5 grs. equal to 35·16 of de-oxygenated ore, or 25·14 of raw ore.

The practical analyfis of this fpecies of the Cumberland ore (a mixture of kidney and hæmatites) may be thus ftated:

Carbonated crude iron obtained in the affay furnace - - - - -	64·5
Water and fulphur - -	6
Oxygen taken up - -	22·5
Earths, chiefly filex, - -	7
	100 parts.

The fpecific gravities of the various ftates of this fpecimen I found to be—in a raw ftate, 4·6623; de-oxygenated, and malleable, 6·3000; combined with oxygen, 5·1900.

IV. *Defcrip-*

IV. *Description of the Lácsha, or Lac Insect**. *By Mr.* W. Roxburgh, *Surgeon on the Madras Establishment. Communicated by Dr.* James Anderson. *From the* Asiatic Researches.

SOME pieces of very fresh-looking Lac, adhering to small branches of Mimosa cinerea, were brought me from the mountains on the 20th of last month. I kept them carefully, and to-day, the 4th of December, fourteen days from the time they came from the hills, myriads of exceedingly minute animals were observed creeping about the lac, and branches it adhered to, and more still issuing from small holes over the surface of the cells: other small and perforated excrescences were observed with a glass amongst the perforations, from which the minute insects issued, regularly two to each hole, and crowned with some very fine white hairs. When the hairs were rubbed off, two white spots appeared. The animals, when single, ran about pretty briskly, but in general they were so numerous as to be crowded over one another. The body is oblong, tapering most towards the tail, below plain, above convex, with a double, or flat margin: laterally on the back part of the thorax are two small tubercles, which may be the eyes: the body behind the thorax is crossed with twelve rings: legs six; feelers (antennæ) half the length of the body, jointed, hairy, each ending in two hairs as long as the antennæ: rump, a white point between two terminal hairs, which are as long as the body of the animal. The mouth I could not see. On opening the cells, the substance that they were formed of cannot be better described, with respect to appearance, than by saying it is like the transparent amber that beads are made of: the external covering of the cells may be about half a line thick, is remarkably strong, and able to resist injuries:

* This discovery of Mr. Roxburgh will bring Lac a genus into the class Hemiptera of Linnæus.

the

the partitions are much thinner: the cells are in general irregular ſquares, pentagons and hexagons, about an eighth of an inch in diameter, and one quarter deep: they have no communication with each other. All thoſe I opened during the time the animals were iſſuing, contained in one half, a ſmall bag filled with a thick red jelly-like liquor, replete with what I take to be eggs: theſe bags, or utriculi, adhere to the bottom of the cells, and have each two necks, which paſs through perforations in the external coat of the cells, forming the fore-mentioned excreſcences, and ending in ſome very fine hairs. The other half of the cells have a diſtinct opening, and contain a white ſubſtance, like ſome few filaments of cotton rolled together, and numbers of the inſects themſelves ready to make their exit. Several of the ſame inſects I obſerved to have drawn up their legs, and to lie flat: they did not move on being touched, nor did they ſhow any ſigns of life with the greateſt irritation.

December 5. The ſame minute hexapedes continue iſſuing from their cells in numbers: they are more lively, of a deepened red colour, and fewer of the motionleſs ſort. To-day I ſaw the mouth: it is a flattened point about the middle of the breaſt, which the little animal projects on being compreſſed.

December 6. The male inſects I have found to-day: a few of them are conſtantly running among the females moſt actively: as yet they are ſcarce more, I imagine, than one to 5000 females, but twice their ſize. The head is obtuſe; eyes black, very large; antennæ clavated, feathered, about $\frac{2}{3}$ the length of the body: below the middle an articulation, ſuch as thoſe in the legs: colour between the eyes a beautiful ſhining green: neck very ſhort: body oval, brown: abdomen oblong, the length of body and head: legs ſix: wings membranaceous, four, longer than the body, fixed to the ſides of the thorax, narrow at their inſertions, growing broader for ^{2} of their length, then rounded; the anterior pair is twice the ſize of the poſterior: a ſtrong fibre runs along

along their anterior margins : they lie flat, like the wings of a common fly when it walks or rests : no hairs from the rump : it springs most actively to a considerable distance, on being touched : mouth in the under part of the head : maxillæ transverse. To-day the female insects continue issuing in great numbers, and move about as on the 4th.

December 7. The small red insects still more numerous, and move about as before : winged insects, still very few, continue active. There have been fresh leaves and bits of the branches of both *Mimosa Cinerea* and *Corinda* put into the wide mouthed bottle with them : they walk over them indifferently, without showing any preference, or inclination to work or copulate. I opened a cell whence I thought the winged flies had come, and found several, eight or ten, more in it, struggling to shake off their incumbrances : they were in one of those utriculi mentioned on the 4th, which ends in two mouths, shut up with fine white hairs, but one of them was open for the exit of the flies ; the other would no doubt have opened in due time : this utriculus I found now perfectly dry, and divided into cells by exceeding thin partitions. I imagine, before any of the flies made their escape, it might have contained about twenty. In these minute cells with the living flies, or whence they had made their escape, were small dry dark-coloured compressed grains, which may be the dried excrements of the flies *.

* The Hindoos have six names for Lac ; but they generally call it Lácshà from the multitude of small insects, who, as they believe, discharge it from their stomachs, and at length destroy the tree on which they form their colonies : a fine Pippala near Crishnanagar is now almost wholly destroyed by them.—NOTE BY THE PRESIDENT.

V. *Mayow anticipated: or, The Discoveries of* HOOKE *relative to the Composition of our Atmosphere. Communicated by* Dr. THORNTON, *Physician to the General Dispensary.*

HOOKE's Micrographia was, by the Council of the Royal Society, ordered to be printed, November 23, 1664.—Speaking of charcoal, Hooke obferves, that "the body to be charred or coaled may be put into a crucible, pot, or any other veffel that will endure to be made red-hot in the fire without breaking, and then covered over with fand, fo as no part of it be fuffered to be open to the air; then fet into a good fire, and there kept till the fand has continued red hot for a quarter, half, an hour or two, or more, according to the nature and bignefs of the body to be coaled or charred; then taking it out of the fire, and letting it ftand till it be quite cold, the body may be taken out of the fand well charred and cleanfed of its waterifh parts; but in the taking of it out, care muft be had that the fand be very near cold, for elfe, when it comes into the free air, it will take fire, and readily burn away.

"This may be done alfo in any clofe veffel of glafs, as a retort, or the like; and the feveral fluid fubftances that come over may be received in a fit recipient, which will yet further countenance this hypothefis: and their manner of charring wood in great quantity comes much to the fame thing, namely, an application of a great heat to the body, and preferving it from the free accefs of the devouring air. This may be eafily learned from the Hiftory of Charring of Coal, moft excellently defcribed and publifhed by that moft accomplifhed gentleman, Mr. John Evelyn, in the 100, 101, 103 pages of his Sylva; to which I fhall therefore refer the curious reader that defires a full information of it.

"Next, we may learn what part of the wood it is that is the combuftible matter; for, fince we fhall find that none, or

very

very little of thofe fluid fubftances that are driven over into the receiver are combuftible, and that moft of that which is left behind is fo, it follows, that the folid interftitia of the wood are the combuftible matter. Further, the reafon why uncharred wood burns with a greater flame than that which is charred, is as evident, becaufe thofe waterifh or volatile parts iffuing out of the fired wood, every way, not only fhatter and open the body, the better for the fire to enter, but, iffuing out in vapours or wind, they become like fo many little æolipiles, or bellows, whereby they blow and agitate the fired part, and conduce to the more fpeedy and violent confumption or diffolution of the body.

" Thirdly, from the experiment of charring of coals (whereby we fee that notwithftanding the great heat, and the duration of it, the folid parts of the wood remain, whilft they are preferved from the free accefs of the air undiffipated) we may learn, that which has not, that I know of, been publifhed or hinted, nay, not fo much as thought of, by any; and that in fhort is this.

" Firft, that the air in which we live, move, and breathe, and which encompaffes very many, and cherifhes moft bodies it encompaffes, that this air is the menftruum, or univerfal diffolvent of all fulphureous * bodies.

" Secondly, that this action it performs not till the body be firft fufficiently heated, as we find requifite alfo to the diffolution of many other bodies by feveral other menftruums.

" Thirdly, that this action of diffolution produces or generates a very great heat, and that which we call fire; and this is common alfo to many diffolutions of other bodies made by menftruums, of which I could give multitudes of inftances.

" Fourthly, that this action is performed with fo great a violence, and does fo minutely act and rapidly agitate the fmalleft parts of the combuftible matter, that it produces in

* A term which, at the time in which the author wrote, meant *any inflammable body.*

the diaphanous medium of the air, the action or pulse of light, which, what it is, I have elsewhere already shewn.

"Fifthly, that the dissolution of sulphureous bodies is made by a substance inherent, and mixt with the air, that is like, if not the very same with that which is fixt in saltpeter, which by multitudes of experiments that may be made with saltpeter, will, I think, most evidently be demonstrated.

"Sixthly, that in this dissolution of bodies by the air, a certain part is united and mixt, or dissolved and turned into the air, and made to fly up and down with it in the same manner as a metalline, or other body dissolved into any menstruums, does follow the motions and progresses of that menstruum till it be precipitated.

"Seventhly, that as there is one part that is dissoluble by the air, so are there other parts with which the parts of the air mixing and uniting do make a coagulum, or precipitation, as one may call it, which causes it to be separated from the air; but this precipitate is so light, and in so small and rarified or porous clusters, that it is very volatile, and is easily carryed up by the motion of the air, though afterwards, when the heat and agitation that kept it rarified ceases, it easily condenses, and commixt with other indissoluble parts, it sticks and adheres to the next bodies it meets withall; and this is a certain salt that may be extracted out of soot.

"Eighthly, that many indissoluble parts being very apt and prompt to be rarified, and so, whilst they continue in that heat and agitation, are lighter than the ambient air, are thereby thrust and carryed upwards with great violence, and by that means carry along with them, not only that saline concrete I mentioned before, but many terrestrial, or indissoluble and irrarifiable parts, nay, many parts also which are dissoluble, but are not suffered to stay long enough in a sufficient heat to make them prompt and apt for that action. And therefore we find in soot, not only a part that, being continued longer in a competent heat, will be dissolved by the

the air, or take fire and burn; but a part alfo which is fixt, terreftrial and irrarifiable.

"Ninthly, that as there are thefe feveral parts that will rarifie and fly, or be driven up by the heat, fo are there many others, that as they are indiffoluble by the aërial menftruum, fo are they of fuch fluggifh and grofs parts, that they are not eafily rarified by heat, and therefore cannot be raifed by it; the volatility or fixtnefs of a body feeming to confift only in this, that the one is of a texture, or has component parts that will be eafily rarified into the form of air; and the other, that it has fuch as will not, without much ado, be brought to fuch a conftitution; and this is that part which remains behind in a white body called afhes, which contains a fubftance, or falt, which chymifts call alkali: what the particular natures of each of thefe bodies are, I fhall not here examine, intending it in another place; but fhall rather add, that this hypothefis does fo exactly agree with all phænomena of fire, and fo genuinely explicate each particular circumftance that I have hitherto obferved, that it is more than probable, that this caufe which I have affigned is the true, adequate, real, and only caufe of thofe phænomena; and therefore I fhall proceed a little further, to fhew the nature and ufe of the air.

"Tenthly, therefore the diffolving parts of the air are but few, that is, it feems of the nature of thofe faline menftruums or fpirits that have very much flegme mixt with the fpirits, and therefore a fmall parcel of it is quickly glutted, and will diffolve no more; and therefore, unlefs fome frefh part of this menftruum be applied to the body to be diffolved, the action ceafes, and the body leaves to be diffolved and to fhine, which is the indication of it, though placed or kept in the greateft heat; whereas faltpeter is a menftruum, when melted and red-hot, that abounds more with thofe diffolvent particles, and therefore, as a fmall quantity of it will diffolve a great fulphureous body, fo will the diffolution be very quick and violent.

"Therefore, in the eleventh place, it is obfervable, that, as in other folutions, if a copious and quick fupply of frefh menftruum, though but weak, be poured on or applied to the diffoluble body, it quickly confumes it: fo this menftruum of the air, if by bellows, or any other fuch contrivance, it be copioufly applied to the fhining body, is found to diffolve it as foon and as violently as the more ftrong menftruum of melted nitre.

"Therefore, twelfthly, it feems reafonable to think that there is no fuch thing as an element of fire that fhould attract or draw up the flame, or towards which the flame fhould endeavour to afcend out of a defire or appetite of uniting with that as its homogeneal primitive and generating element; but that that fhining tranfient body which we call flame, is nothing elfe but a mixture of air and volatile fulphureous parts of diffoluble or combuftible bodies, which are acting upon each other whilft they afcend, that is, flame feems to be a mixture of air and the combuftible volatile parts of any body, which parts the encompaffing air does diffolve or work upon, which action, as it does intend the heat of the aërial parts of the diffolvent, fo does it thereby further rarifie thofe parts that are acting, or that are very near them, whereby they growing much lighter than the heavie parts of that menftruum that are more remote, are thereby protruded and driven upward; and this may be eafily obferved alfo in diffolutions made by any other menftruum, efpecially fuch as either create heat or bubbles. Now, this action of the menftruum or air on the diffoluble parts, is made with fuch violence, or is fuch, that it imparts fuch a motion or pulfe to the diaphanous parts of the air, as I have elfewhere fhewn is requifite to produce light.

"This hypothefis I have endeavoured to raife from an infinity of obfervations and experiments, the procefs of which would be much too long to be here inferted, and will perhaps another time afford matter copious enough for a much larger difcourfe, the air being a fubject which (though all the

the world has hitherto lived and breathed in, and been unconverfant about) has yet been fo little truly examined or explained, that a diligent enquirer will be able to find but very little information from what has been (till of late) written of it: but being once well underftood, it will, I doubt not, enable a man to render an intelligible, nay probable, if not the true reafon of all the phænomena of fire, which, as it has been found by writers and philofophers of all ages a matter of no fmall difficulty, as may be fufficiently underftood by their ftrange hypothefes and unintelligible folutions of fome few phænomena of it; fo will it prove a matter of no fmall concern and ufe in human affairs, as I fhall elfewhere endeavour to manifeft when I come to fhew the ufe of the air in refpiration, and for the prefervation of the life, nay, for the confervation and reftauration of the health and natural conftitution of mankind as well as all other aërial animals, as alfo the ufes of this principle or propriety of the air in chymical, mechanical, and other operations. In this place I have only time to hint an hypothefis, which, if God permit me life and opportunity, I may elfewhere profecute, improve and publifh."

This appears to be exactly the doctrine of Mayow, who firft publifhed his treatife on refpiration in 1668, and his other treatifes on the compofition of nitre, &c. in 1674, fhewing clearly the priority of Hooke.

VI. *On a New Kind of Sympathetic Ink.* *By* M. Meyer. *From* Crell's Chemical Annals, *Vol. I.* 1798.

A TRAVELLER, who wifhed to have fympathetic ink of a rofe red colour, fhewed me a receipt he had procured for preparing an ink of that kind; according to which, cobalt was to be diffolved in the nitrous acid, and a quantity of faltpetre, equal to that of the cobalt diffolved, was to be added to the folution; but as this procefs had never fucceeded with him, I reſolved to make ſome experiments to aſcertain the point. My firſt object was to procure pure cobalt; but as I was unwilling to ſacrifice pure pieces of any conſiderable ſize, I made choice of one which was viſibly mixed with biſmuth, iron and quartz. I endeavoured to ſeparate the biſmuth as much as poſſible, and alſo the arſenic if it ſhould contain any, by bringing it ſlowly to a red heat; and I ſucceeded pretty well, as the biſmuth flowed from it in abundance; and the arſenic, the quantity of which was ſmall, was volatiliſed: many globules of biſmuth ſtill adhered to it. By bringing it repeatedly to a red heat, and then quenching it in water, it was reduced to ſuch a ſtate as to be eaſily pulveriſed. Having poured nitrous acid upon the powder, I obtained by digeſtion a beautiful roſe red ſolution; the ſiliceous earth was ſeparated in the form of a white ſlime, and by diluting it with water there was depoſited a white powder, which was oxyd of biſmuth. The ſolution being filtered, I added to it a ſolution of potaſh, and obtained a precipitate inclining more to a yellow than to a red colour. I again poured over it a little of the nitrous acid, by which a part of the oxyd was re-diſſolved of a red colour: the remaining part, which had a dark brown colour, was oxyd of iron. From the ſolution, by the addition of potaſh, a precipitate was formed, which was now reddiſh. Having by this proceſs obtained it pure; that I might now prepare from it the wiſhed for red ink, I diſſolved the waſhen pure oxyd of cobalt in different acids. That diſſolved in the nitrous acid with a mixture of nitre, gave a green ink like the common: that diſſolved in the ſulphurous acid, without the addition of ſalts, gave a reddiſh ink, which remained after it was expoſed to heat, and would not again diſappear, even when a ſolution of nitre was applied; and that diſſolved in the muriatic acid gave a green ink, darker and more beautiful than the common. By diſſolving it, however, in the acetous acid, and adding a little nitre, I obtained what I had in view; for it gave, on the application of heat, an ink of a red colour, like that of the *roſa centifolia*, which again diſappeared when the paper became cold. I was not able to obtain it of a darker tint; but I muſt confeſs that I made only a few experiments for that purpoſe, as I was ſatisfied with the colour I had got.

VII. *Deſcription of* M. de Saussure's *Diaphanometer. By Dr.* F. W. Aug. Murhard, *of Gottingen. From* Neues Journal der Phyſik, *by Profeſſor* Gren. *Vol. IV.*

THIS inſtrument, firſt deſcribed by M. de Sauſſure in the fourth volume of the Memoirs of the Royal Academy of Sciences at Turin, has ſome reſemblance to the *cyanometer* *, both in regard to its object and conſtruction. The principal difference is, that the latter ſhews the whole effect of the vapour and evaporation diffuſed throughout the atmoſphere, from the eye of the obſerver to the utmoſt boundary of his view; while the diaphanometer is, on the other hand, deſigned to ſhew the greatneſs of the evaporations exiſting in any limited part of the atmoſphere which ſurrounds us.

The meaſure of tranſparency in M. de Sauſſure's inſtrument, is founded on the proportion of the diſtances at which determined objects ceaſe to be viſible; and the point was to find objects, the diſappearance of which, at a certain diſtance, could be determined with the greateſt accuracy. M. de Sauſſure found that the moment of diſappearance can be obſerved much more accurately when a black object is placed on a white ground, than when a white object is placed on a black ground; that the accuracy was ſtill greater when the obſervation was made in the ſun, than in the ſhade; and that even a ſtill greater degree of accuracy was obtained, when the white ſpace ſurrounding a black circle, was itſelf ſurrounded by a circle or ground of a dark colour. This laſt

* An inſtrument for determining the degree of the blueneſs of the heavens.

circumſtance

circumftance was particularly remarkable, and an obfervation quite new.

If a circle totally black, of about two lines in diameter, be faftened on the middle of a large fheet of paper or pafteboard, and if this paper or pafteboard be placed in fuch a manner as to be expofed fully to the light or the fun, if you then approach it at the diftance of three or four feet, and afterwards gradually recede from it, keeping your eye conftantly directed towards the black circle, it will appear always to decreafe in fize the farther you retire from it, and at the diftance of 33 or 34 feet will have the appearance of a point. If you continue ftill to recede, you will fee it again enlarge itfelf; and it will feem to form a kind of cloud, the darknefs of which decreafes more and more according as the circumference becomes enlarged. The cloud will appear ftill to increafe in fize, the farther you remove from it; but at length it will totally difappear. The moment of the difappearance, however, cannot be accurately afcertained; and the more experiments were repeated, the more were the refults different. This is an obfervation perfectly accurate; and having myfelf made a feries of experiments under like circumftances, I am the more convinced of the truth of it.

M. de Sauffure, having reflected for a long time on the means of remedying this inconveniency, faw clearly, that, as long as this cloud took place, no accuracy could be obtained; and he difcovered that it appeared in confequence of the contraft formed by the white parts which were at the greateft diftance from the black circle. He thence concluded, that if the ground was left white near this circle, and the parts of the pafteboard at the greateft diftance from it were covered with a dark colour, the cloud would no longer be vifible, or at leaft almoft totally difappear.

This conjecture was confirmed by experiment. M. de Sauffure left a white fpace around the black circle equal in breadth to its diameter, by placing a circle of black paper a line in diameter on the middle of a white circle three lines

in

in diameter, so that the black circle was only surrounded by a white ring a line in breadth. The whole was pasted upon a green ground. A green colour was chosen, because it was dark enough to make the cloud disappear, and the easiest to be procured.

The black circle, surrounded in this manner with white on a green ground, disappeared at a much less distance, than when it was on a white ground of a large size.

If a perfectly black circle, a line in diameter, be pasted on the middle of a white ground exposed to the open light, I can observe it at the distance of from 44 to 45 feet; but if this circle be surrounded by a white ring a line in breadth, while the rest of the ground is green, I lose sight of it at the distance of only $15\frac{1}{2}$ feet.

According to these principles M. de Saussure delineated several black circles, the diameters of which increased in a geometrical progression, the exponent of which was $\frac{3}{2}$. His smallest circle was $\frac{1}{5}$ or 0·2 of a line in diameter; the second, 0·3; the third, 0·45; and so on to the sixteenth, which was 87·527, or about 7 inches $3\frac{1}{2}$ lines. Each of these circles was surrounded by a white ring, the breadth of which was equal to the diameter of the circle, and the whole was pasted on a green ground.

M. de Saussure, for his experiments, selected a straight road or plain of about 12 or 1500 feet in circumference, which towards the North was bounded by trees or an ascent. Those who repeat them, however, must pay attention to the following remarks:—When a person retires backwards, keeping his eye constantly fixed on the pasteboard, the eye becomes fatigued, and soon ceases to perceive the circle; as soon therefore as it ceases to be distinguishable, you must suffer your eyes to rest; not, however, by shutting them, for they would when again opened be dazzled by the light, but by turning them gradually to some less illuminated object in the horizon. When you have done this for about half a minute,

and

and again directed your eyes to the paſteboard, the circle will be again viſible, and you muſt continue to recede till it diſappear once more. You muſt then let your eyes reſt a ſecond time in order to look at the circle again, and continue in this manner till the circle becomes actually inviſible.

If you wiſh to find an accurate expreſſion for the want of tranſparency, you muſt employ a number of circles, the diameters of which increaſe according to a certain progreſſion, and a compariſon of the diſtances at which they diſappear will give the law according to which the tranſparency of the atmoſphere decreaſes at different diſtances. If you wiſh to compare the tranſparency of the atmoſphere on two days, or in two different places, two circles will be ſufficient for the experiment.

According to theſe principles, M. de Sauſſure cauſed to be prepared a piece of white linen cloth eight feet ſquare. In the middle of this ſquare he ſewed a perfect circle, two feet in diameter, of beautiful black wool; around this circle he left a white ring two feet in breadth, and the reſt of the ſquare was covered with pale green. In the like manner, and of the ſame materials, he prepared another ſquare; which was, however, equal to only 1/12 of the ſize of the former, ſo that each ſide of it was 8 inches; the black circle in the middle was two inches in diameter, and the white ſpace around the circle was 2 inches alſo.

If two ſquares of this kind be ſuſpended vertically and parallel to each other, ſo that they may be both illuminated in an equal degree by the ſun; and if the atmoſphere, at the moment when the experiment is made, be perfectly tranſparent, the circle of the large ſquare, which is twelve times the ſize of the other, muſt be ſeen at twelve times the diſtance. In M. de Sauſſure's experiments the ſmall circle diſappeared at the diſtance of 314 feet, and the large one at the diſtance of 3588 feet, whereas it ſhould have diſappeared at the diſtance of 3768. The atmoſphere, therefore, was not perfectly tranſparent.

transparent. This arose from the thin vapours which at that time were floating in it.

It is of great importance to ascertain the laws according to which the distinctness of the visibility of an object decreases, either when the transparency of the medium through which the object is viewed is lessened, or when the thickness of the stratum of the medium is increased. Lambert, in his Photometry, has given an account of many ingenious experiments which he made on the decrease of the quantity of light, by its propagation through a medium imperfectly transparent; but M. de Saussure is the first who has considered the decrease of the distinctness with which an object is seen through such a medium at different distances.

VIII. *History of Astronomy for the Year* 1798. *Read in the College de France, Nov.* 20. *By* JEROME LALANDE, *Inspector and Dean of the College, and formerly Director of the Observatory.*

BEING permitted for the tenth time to entertain the public with the progress of a science which has engaged my attention fifty years, I am happy in being able to announce things still more interesting than on the last occasion; and, in the first place, the conclusion of that grand operation the measurement of the earth, or of $9\frac{2}{3}$ degrees of the meridian from Dunkirk to Barcelona.

About the middle of January, Delambre, impatient to begin his fatiguing labours, proceeded, notwithstanding the cold and the rain, to prepare a base from Lieursaint to Melun; to complete the wooden pyramids, which were seventy feet in height, and to measure the angles.

On the 24th of February he had already finished seven stations for the angles at the base: three men had been employed for six weeks to cut down and remove from the highway

way six or seven hundred trees which interrupted the view of the signals.

On the 17th of April he set out to measure the base from Melun to Lieursaint; a laborious operation, to which so much attention was paid that, though assisted by seven persons, they measured only 180 toises a day.

On the 3d of June the measurement of the base of three leagues, 6075 toises, was finished at Lieursaint.

On the 30th of June C. Delambre set out to measure the base of Perpignan, which was terminated by the middle of September. At the same time C. Mechain finished his triangles between Rodez and Carcassone, after being exposed to illness, impediments, and delays of every kind. Being more unfortunate, and less robust than his colleague, his zeal served only to torment him the more.

On the 17th of November they at length arrived at Paris, after finishing their calculations, from which it appeared that the two bases perfectly agreed. Thus this immense enterprise of a new measurement of the earth, begun in the month of June 1792, by our two ablest astronomers, is at length terminated; and we shall soon have the results so much wanted, for the size and figure of the earth, and perhaps for its irregularities. These two astronomers mean also to determine again the latitude of Paris, which I had fixed at 48° 50′ 15″ three years ago, from two hundred observations, made with an astronomical circle, for which we are indebted to C. Borda, by diminishing the refraction of Bradly one second, and this is all the uncertainty that remains.

The grand labour of determining the position of the stars, begun in 1789, has been carried to 47,000; and there remains only 2000 to complete the tour of the heavens as far as the lower tropic. By taking two degrees beyond it, there will be 50,000. C. Lefrançais proposes to finish this labour next winter. Comets are at present the only part of astronomy in which little progress has been made; but it is now about

about to engage the attention of our astronomers. I was desirous of preparing for them the only assistance which was wanting, by giving them the positions of the stars in every part of the heavens. They will never be able to observe comets without being obliged to have recourse to our 50,000 stars, and without being certain of finding there every thing they could wish: I know this by the experience of several years.

But detractors will never be wanting to every great and important work; they will say it would be much better to have fewer stars, and to have their positions ascertained with more accuracy. They are however mistaken; it is the great number of stars that supplies the data requisite for this labour: a greater precision is useless at present, and will be so for a long time. Comets are never observed nearer than 30 seconds, and yet they wish to have the positions of the stars to one second; this is an evident absurdity, and a manifest impossibility. We have then done every thing that was necessary and possible to be done; and I consider myself happy in having terminated my career, by procuring for astronomy a monument which, on account of its magnitude, might have been thought impossible. To shew the utility of C. Lefrançais' labour, it will be sufficient to say, that in a zone of three hours, having two degrees of breadth, there were thirty new stars of the fifth and sixth, and between the sixth and the seventh magnitudes, yet no more than three of them were known. On the 10th of December 1789, of one hundred stars, thirteen of which were of the sixth magnitude, there was only one known: the other twelve are new to us. This is enough to prove how far we were from being acquainted with the starry heavens, and from knowing how many stars were visible to the naked eye. For that reason I was induced to employ myself in this labour as soon as I was able to procure a good instrument. M. Herschel has also undertaken a review of the heavens with his twenty-feet telescope, but only for the purpose of finding nebulæ, or objects difficult to be seen.

Our labour is more important, since it gives the exact position of all the stars which astronomers may have occasion to use. Herschel observes only things invisible, and astronomers have need of sensible objects that are always present to their view.

We may therefore say of C. Lefrançais, what Virgil said of Palinurus: *Sydera cuncta notat tacito labentia cœlo*; for he has really done what Palinurus never did. C. Lefrançais has already reduced 6000, and he promises 4000 for the present year, though each requires thirty-six operations. In the month of September I caused to be erected in the Military School a new meridian telescope by Lenoir, with a large object-glass by Caroché: it is better placed than the former; the supports have no connection with the roof, and the instrument is less subject to vary by the changes of temperament. With this instrument we shall continue to determine the right ascension of the principal stars of all our zones of fifty thousand.

The theory of physical astronomy has also had a remarkable epoch this year. C. Laplace, to whom we are indebted for an explanation of the acceleration of the moon, has found that the apogeum and node have likewise secular equations; and this noble discovery has been confirmed by a great number of observations. It would be useful to confirm it still farther, by the observations of the middle ages, of which there are a few. The manuscript of Ibn-Iunis, an Arabian of the tenth century, contains valuable observations: the original is at Leyden, and we have made fruitless efforts to obtain a copy of it. C. Caussin, one of our professors of Arabic, offered to go to Leyden and copy the observations; but I have found a copy among the manuscripts of J. Delisle, my predecessor in the *College de France*, and I hope we shall soon have the results of these valuable observations.

On the 19th of March, the Institute proposed, as the subject of a prize, a comparison of 500 observations of the moon, with the tables to determine better the 22 equations which we employ at present for the moon's motion; and I already know

know a competitor who has made immenſe calculations on that ſubject. Our prize will ſerve to terminate and render public that important labour which, united to Laplace's theory, will bring the moon's tables, and the calculation of the longitude, to a new degree of preciſion. If errors of three myrametres (ſeven leagues) were formerly committed at ſea through the fault of the tables, they will ſoon be reduced to two or three.

C. Meſſier, who continues to ſearch for comets, diſcovered one on the 12th of April 1798, towards the Pleiades; it was ſmall, and without any tail, but of conſiderable brilliancy: it could not be diſtinguiſhed by the naked eye. It forms the twenty-firſt which C. Meſſier has diſcovered ſince 1758, and the forty-firſt he has obſerved. The number of the comets now known is 88, according to the catalogue in my aſtronomy. Dr. Burckhardt, an able aſtronomer of Gotha, who had been ſome months at Paris, loſt no time to calculate the orbit of this comet, which he did in two days, a circumſtance very extraordinary. I have publiſhed C. Meſſier's obſervations, which Dr. Burckhardt reduced and calculated by employing ſeveral poſitions of the new ſtars furniſhed by C. Lefrançais, my nephew. This comet was almoſt as remote from us as the ſun, and its diſtance varied little for a month. It ceaſed to be viſible after the 24th of May. I had traced out its courſe on paſteboard for my auditors, as I generally do, and any one could there ſee its diſtance and ſituation for each day. C. Bouvard, at the obſervatory, made alſo various obſervations, which we ſhall publiſh with thoſe of C. Meſſier, until they appear more at large in the Memoirs of the National Inſtitute, with a chart of its courſe, as C. Meſſier always gave in the Memoirs of the ci-devant Academy. Dr. Olbers at Bremen obſerved it alſo as ſoon as he was informed of it by the *Journal de Paris*.

But before this real comet, Paris reſounded with the report of a pretended comet. On the 16th of January a new comet was announced on the Pont-Neuf, and many people were frightened. It however turned out to be only Venus, which was seen during the open day over the Luxembourg, at a time when 20,000 persons assembled to see General Bonaparte had their eyes directed towards that quarter. With proper attention, Venus might be seen in the like manner every 19 months; but few people have time or opportunity to make such observations. On this occasion the terror was singular. A piece called the *Comet*, or the *End of the World*, was represented at the Vaudeville. Ruggieri exhibited an artificial comet at the Lyceum: it had a great resemblance to the beautiful comet of 1744, which I recollect to have seen, and which was the most astonishing of that century.

On the 6th of December 1798, in the evening, C. Bouvard discovered a small comet in the constellation of Hercules. This makes the 89th. It was observed till the 11th, when it disappeared in Aquarius. It moved at the rate of eighteen degrees per day. Though it appeared only five days, we have, therefore, sufficient data to calculate its orbit. It was seen at Bremen by Dr. Olbers.

On the 21st of November a comic opera, called the Astronomer, was represented at the theatre in the *Rue Feydeau.* It is founded on a circumstance similar to that of the *Total Eclipse*; the first idea of which seems to have been borrowed from *Les Memoires Turcs.* It exhibits an old simpleton deceived while he pretends to observe a comet.

On the 18th of January, C. Dangos, at Tarbes, saw a comet pass over the sun like a black spot. This new and singular observation may be useful when we become acquainted with a great number of comets; but we are totally ignorant of the course of the one which was seen that day on the sun's disk.

An important and celebrated voyage has given new hopes to astronomy and geography. On the 16th of March government expressed a desire of having select astronomers and instruments for a secret expedition. We soon learned that the famous General Bonaparte was to be at the head of it. I could recommend only citizens Nouet, Quenot, and Mechain the son. They gladly embarked in this noble enterprize, and set out on the 24th of April. On the 10th of May they sailed from Toulon, landed in Egypt on the 2d of July; and I have no doubt that this voyage will be useful to geography, and even astronomy. I have written to all the astronomers of Europe to request them to co-operate, by corresponding observations, with those which will be made by the astronomers of that expedition.

Young Bernier, of Montauban, was desirous of sharing in the voyage, but we applied for him too late. I recommended to the attention of our astronomers, the level of the Mediterranean and the Red Sea, in which it has been often said there is a great difference, but I do not believe it. I have written to Spain to procure information in regard to that of the South Sea and the Gulph of Mexico, at the Isthmus of Panama, respecting which the like difficulties have been started.

The observatory of Gotha is the most beautiful and most useful in Germany. The duke has expended on it more than 200,000 livres. No prince or king in the present century has followed his example. M. von Zach, the director of the observatory, is one of the most celebrated astronomers in Europe. I had long wished to visit and be acquainted with the only monument of astronomy which I had not seen, after the example of Halley, who went from England to Denmark in 1679, to see the observatory of Hevelius, to converse with him, and examine the accuracy of his observations. I have found that M. von Zach can observe the polar star to a second, instead of a hundred seconds, which we had of uncertainty. Several German astronomers, being informed of this design, assembled there also. Our conferences served to increase our emulation. I brought back 1200 ascensions of zodiacal stars, each observed several times by M. von Zach, with the most beautiful transit instrument in existence. They will appear, together with 3000 declinations which I have sent to M. von Zach, in an important work he is about to publish on astronomy, in two volumes octavo, and of which two thirds are already printed.

M. Bode brought from Berlin drawings of his thirteenth chart of the starry heavens. There will be twenty in the whole; and this collection, of the utmost value to astronomers, will contain 13,000 stars, or 8000 more than ever were represented before. He has reduced 3000 of Lacaille's stars, and has observed 1500 himself to fill up vacancies; C. Lefrançais supplied him with the rest. There will be found in it the 2000 nebulæ of Herschel, and from five to six hundred double stars of that celebrated astronomer. We have formed two new constellations, the Press of Guttemberg, and Mongolfier's Balloon.

M. Wurm came to meet us from Wirtemberg, the distance of a hundred leagues. The duke of Wirtemberg gave him a gratuity of 800 livres. He assured me that he would still collate the new stereotype tables of C. Firmin Didot, in order that this undertaking, which must ensure correctness to our calculations for more than a century, may be rendered as perfect and useful as possible.

Messrs. Klugel, Gilbert and Pistor, came from Halle, a celebrated university in the king of Prussia's dominions, and M. Schaubach from Meinungen. M. Seyffer, of Gottingen, promised us some observations and calculations, of which we are in want. M. Köhler brought with him a new photometer to measure the light of the stars, and a reflecting selenostate, which is a very ingenious machine. M. Feer, of Zurich, brought a chart of the Rinthal, constructed from observations with a sextant. All these philosophers agreed to recommend the new system of measures, and to employ the mean time and decimal reckoning in their calculations. M. Seyffert, of Dresden, gave me a stop watch, with the hour plate divided according to the decimal method which was executed by himself. We went to the top of the

mountain

mountain of Inſelberg, with chronometers, ſextants, and artificial horizons of different forms, in order to compare them; and I am fully convinced that the geography of Germany will ſoon be improved by the uſe of theſe inſtruments, which M. von Zach has recommended and made better known.

This uſeful congreſs would perhaps have been more numerous; but M. Vega wrote to me from Auſtria, that he was not able to obtain permiſſion to meet us at Gotha; and, what is ſtill worſe, he was obliged to ſend my letter, and his own anſwer, to the miniſter for his inſpection. The king of Pruſſia, on the other hand, made an addition of 1200 livres to the allowance of his aſtronomer on account of this journey. The aſtronomer of Gottingen, though a ſubject of the king of England, experienced no difficulty.

An Engliſh Journal had hinted to the duke of Gotha, that a French aſtronomer might perhaps be employed with other revolutions than thoſe of the heavenly bodies; but I did not find that this ſuggeſtion diminiſhed in the leaſt the favourable reception I had been taught to expect. We at laſt ſeparated, after being fully convinced of the utility of ſuch conferences, and with a reſolution of renewing them as often as we could *.

[To be concluded in next Number.]

IX. *Obſervations and Experiments in regard to the Figures formed by Sand, &c. on Vibrating Surfaces, by* J. G. VOIGT. *From* Neues Journal der Phyſik, *by Profeſſor* GREN, *Vol. III.*

DR. CHLADNI of Wittemberg, by his experiments on vibrating ſurfaces, in the year 1787, opened a new field in mechanics, viz. the conſideration of the curves formed by ſurfaces put in a ſtate of movement. His diſcoveries, there-

* For Profeſſor Bode's account of this meeting of aſtronomers, ſee p. 324 of the preſent volume.

fore, were fo much the more valuable; but, as far as I know, few befides himfelf have employed their attention on this fubject, and perhaps becaufe it requires long practice to perform experiments of this nature, fo as to make progrefs in a branch of fcience hitherto uncultivated. But, until thefe experiments fhall more engage the attention of philofophers, we cannot expect that the fubject will be much illuftrated; and therefore I conceive it may be of fome utility if I here give a fhort account of the method of making experiments on vibrating furfaces, which I hope will enable any one to repeat them with facility.

I have for fome time paft turned my attention to fuch experiments, and I flatter myfelf that I have made improvements in regard to thofe which Dr. Chladni announced in his *New Theory of Sound*. By my experiments I was conducted to many rules, a knowledge of which will render it very eafy to repeat thefe experiments. I made them according to the inftructions given by Dr. Chladni in the work above mentioned, which appears to me, however, to be rather too fhort.

The vibration figures arife, it is well known, becaufe during the movement of a furface, which is connected with the fenfation of found in our organs of hearing, fome parts of the furface are at reft, and others in motion. If the furface be ftrewed over with bodies eafily put in motion, fuch for example as fand, thefe during the vibration remain on the parts at reft, and are thrown from the parts in motion. The form of the parts at reft, which will be fhewn by the fand that remains unmoved, and which in general is fymmetric, is called a vibration figure. To produce fuch a figure, nothing is neceffary but to know the method of bringing that part of the furface which you wifh not to vibrate into a ftate of reft, and of putting in motion that which you wifh to vibrate: on this depends the whole expertnefs of producing vibration figures.

The furfaces fitteft for being made to vibrate, are panes of glaſs, though the experiments will ſucceed equally well with plates of metal, or pieces of board, of a line or two in thickneſs. One might now believe that to produce fig. 2. (*See Plate* VIII.) it would be neceſſary to damp, in particular, every point of the part to be kept at reſt, viz. the two concentric circles and the diameter, and to put in motion every part intended to be made to vibrate. This, however, is not the caſe; for you need damp only the points *a* and *b*, and cauſe to vibrate one part *c* at the edge of the plate, for the movement is ſoon communicated to the other parts which you wiſh to vibrate, and the required figure will in this manner be produced. How and why the movement takes place in this manner, and in no other, is difficult to be explained, and would lead me too far, as I wiſh merely to give a few rules for making the experiments.

The damping may be beſt effected by laying hold of the place to be damped between two figures, or by ſupporting it only by one finger. This will be comprehended more clearly by turning to fig. 6. where the hand is repreſented in that poſition neceſſary to hold the plate. In order to produce fig. 3. you muſt hold the plate horizontally, placing the thumb above at *a*, with the ſecond finger directly below it; and, beſides this, you muſt ſupport the point *b* on the under ſide of the plate. If you then rub the bow of a violin againſt the plate at *c*, you will produce on the glaſs the figure which is delineated fig. 3. When the point to be ſupported or damped lies too near the centre of the plate, you may reſt it on a cork, not too broad at the end, in contact with the glaſs, in order to ſupply the place of the finger. It is convenient alſo, when you wiſh to damp ſeveral points at the circumference of the glaſs, to place your thumb on the cork, and uſe the reſt of your fingers for touching the parts which you wiſh to keep at reſt. For example, if you wiſh to produce fig. 4. on an elliptic plate, the larger axis of which is to the leſſer as 4 to 3, you muſt place the cork under the centre *c* of the plate; put your thumb upon this point, and then damp the two points of the edge *p* and *q*, as may be ſeen fig. 5. and make the plate to vibrate by rubbing the violin bow againſt it at *r*. There is ſtill another convenient method of damping ſeveral points at the edge when you employ large plates. Fig. 1. repreſents a ſtrong ſquare bit of metal *a b*, a line in circumference, which is ſcrewed to the edge of a table, or made faſt in any other manner; and a notch about as broad as the edge of the plate is cut into one ſide of it with a file. You then hold the plate, reſting againſt this bit of metal by two or more fingers when requiſite, as at *c* and *d*; by which means the edge of the plate will be damped in three points *d*, *c*, *e*; and in this manner, by putting the plate in vibration at *f*, you can produce fig. 10. In caſes of neceſſity you may uſe the edge of a table inſtead of the bit of metal; but it does not anſwer the purpoſe ſo well.

To produce the vibration at any required place, a common violin bow rubbed with reſin is the moſt proper inſtrument to be employed. The hair muſt not be too ſlack, becauſe it is ſometimes neceſſary to preſs pretty hard on the plate, in order to produce the tone ſooner.

When you wiſh to produce any particular figure, you muſt firſt form it in idea upon the plate, in order that you may be able to determine where a line at reſt and where a vibrating part will occur. The greateſt reſt will always be where two or more lines at reſt interſect each other; and ſuch places muſt, in particular, be damped. For example, in fig. 7. you muſt damp the part *n*, and ſtroke with the bow in *p*. Fig. 11. may be produced with no leſs eaſe, if you hold the plate at *r*, and ſtroke with the bow at *f*. The ſtrongeſt vibration ſeems always to be in that part of the edge which is bounded by a curve: for example, in fig. 8. and fig. 9. at *n*. To produce theſe figures, therefore, you muſt rub with the bow at *n*, and not at *r*.

You muſt, however, damp not only thoſe points where two lines interſect each other, but endeavour to ſupport at leaſt one which is ſuited to that figure and to no other.

For

For example, when you ſupport *a* and *b* (*fig.* 2.), and rub with the bow in *c*, fig, 7. alſo may be produced, becauſe theſe figures have both theſe points at reſt. To produce fig. 2. you ſupport with one finger the part *e*, and rub with the bow in *c*; and in this manner fig. 7. cannot be produced, becauſe it has not the point *e* at reſt. One of the greateſt difficulties in producing the figures is to determine before hand the vibrating and reſting points which belong to a certain figure and to no other.

Hence it happens that when one is not able to ſupport thoſe points which diſtinguiſh one figure from another, if the violin bow be rubbed againſt the plate, ſeveral hollow tones are heard without the ſand forming itſelf as expected. One muſt therefore acquire by experience a readineſs in being able to ſearch out, among theſe tones, that which belongs to the required figure, and to produce it on the plate by rubbing the bow againſt it. But it requires great practice to determine the figure previouſly from the tone, or to ſearch out, among various tones, that which belongs to the figure, and to know how to make the plate vibrate in ſuch a manner that this tone alone, and not another, ſhall be heard. For this purpoſe you muſt firſt liſten, and then alter the mode of rubbing; and as ſoon as the right tone is produced, you muſt rub ſomewhat harder with the violin bow, by preſſing it more ſtrongly againſt the edge of the plate. The latter muſt be done in particular in regard to high tones. As ſoon as you have acquired ſufficient expertneſs in this reſpect, you can, as I myſelf have experienced, determine before hand, with a conſiderable degree of certainty, the figures to be produced, and even the moſt difficult. This practice will be attended with the greateſt advantage, if, when you rub the bow againſt the plate for the firſt time in order to produce a figure, you continue the rubbing that the tone may be imprinted in the memory, and if you try, after ſome time, to produce the ſame tone again. It may be readily conceived that you muſt not forget what parts of the plate, and in what manner you damped;

damped; and you may mark these points by making a scratch on the plate with a bit of flint.

When the plate has acquired the proper vibration, you must endeavour to keep it in that state for some seconds, which can be best done by rubbing the bow several times in succession. By these means the sand will be formed much more accurately.

Any sort of glass may be employed for these experiments, provided its surface be smooth; otherwise the sand will fall into the hollow parts, or be thrown about in an irregular manner. The surface of the common green glass is, however, not very smooth, and often full of cavities. The figures, therefore, formed upon it are not so clear and accurate as those formed upon smooth white glass, which is the kind I employ.

When there are several places on the plate where there are stripes in the mass of the glass, they hurt the experiments, especially in producing those figures where a vibrating part falls upon several of these stripes. In that case the figures are not so symmetric as on other plates. I have in my possession, for example, a circular plate of glass 20 inches in diameter, on which I was never able to produce a perfect circle as on other plates, the circle always appearing like a very long ellipse. This plate contains a great many of the above-mentioned stripes. The flaws and knots which occur in glass are not very hurtful.

Common glass plates, when cut with a stone, are very sharp on the edge, and would soon destroy the hair of the violin bow: on this account the edge must be rendered somewhat smooth. For that purpose I employ a file or a piece of coarse hard free stone. It is of no great consequence, according to my observations, whether the edges be very smooth or roughly ground, provided they be in such a state as not to injure the hair of the bow.

You must endeavour to procure such plates as are pretty equal in thickness. It may be said, in general, that a plate

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the thinner it is will be ſo much the fitter for theſe experiments, though in this reſpect there is a certain minimum. In ſmall plates, ſuch as thoſe that are circular, and not above ſix inches in diameter, the obſervation is general; but in larger plates too great thinneſs is prejudicial. Beſides, it will be found that very thin glaſs is commonly very uneven, and, as has been already ſaid, muſt therefore be unfit for the experiments. If you have a plate, however, which is on one ſide thicker than on the other, you muſt endeavour to produce the figure on the plate in ſuch a manner that you can rub the violin bow againſt the thinneſt part.

In the laſt place, in practiſing the experiments, you muſt have glaſs plates of different ſizes, ſuch, for example, as circular ones of from four to twelve inches in diameter: for, on a ſmall one of four inches in diameter, you cannot produce three concentric circles with two or more diameters; and on a larger, for example, of twelve inches of diameter, you cannot ſo eaſily produce a ſingle circle as on a circular plate of three inches diameter. Sometimes it is difficult to make the figure appear on a plate, while on another it is very eaſy. Sometimes it appears only when you hold the plate in a certain place. Theſe are phenomena which ariſe partly from the unlike thickneſs of the glaſs, and partly from the ſtripes and flaws in it.

You muſt not employ too fine ſand, but rather that which is coarſer; becauſe the former is eaſier thrown from the vibrating parts, while the latter adheres better to them. It muſt be of ſuch a nature that when you incline the glaſs-plate it may readily roll off; becauſe, in that caſe, it will be eaſily thrown from the vibrating parts. It will be of advantage that it be mixed with fine duſt, which ſhews peculiar phenomena during the experiments, as it collects itſelf at one place of the vibrating part.

The plate muſt be equally beſtrewed with ſand, and not too thick, as the lines will then be exceedingly fine, and the figures will acquire a better defined appearance.

Thoſe

Those who wish to exercise themselves in these experiments may try to produce the figures spoken of by Dr. Chladni, in his before-mentioned work, following his directions, and the rules here given: but they must not be discouraged if the figures are not produced on the first trials; for, in general, to learn the method of making the experiments requires some time.

The above rules contain some general laws which vibrating surfaces follow; but as my object here was to give only a short view of the manner in which experiments must be made, I shall not enter into a further explanation of these laws, as I mean to treat the subject more fully on some other occasion.

X. *Communication from Mr.* Cruickshank, *Chemist to the Ordnance, relative to a Mistake in the last Edition of Dr.* Smyth's Treatise on the Effects of Nitrous Vapour in preventing and destroying Contagion. *With an Account of the Methods now employed at Woolwich for fumigating with the Sulphurous Acid, and with Oxygenated Muriatic Acid Gas.*

TO THE EDITOR OF THE PHILOSOPHICAL MAGAZINE.

SIR,

IN the last edition of Dr. Smyth's Treatise on the effects of nitrous vapour in preventing and destroying contagion, I was not a little surprised to find, at page 221, the following passage, in a letter to Dr. Percival, dated August 1, 1796:

"Whether this will apply to the small-pox, I cannot say "from my own experience; but I have been told by Dr. Rollo "surgeon to the artillery, and Mr. Cruickshank professor-royal "of chemistry to the academy, that it destroys the miasma of "small-pox; and that, of two quantities of matter taken for "the purpose of inoculation, one was exposed to the nitrous "vapour, the other not: the persons inoculated with the

 "first

" first were not seized with the disease, whilst the inoculation " took the usual effect when performed with the second."

In the conversation which Dr. Rollo and myself had with Dr. Smyth, about the different methods of destroying contagion, I gave it as my opinion, that the ox. muriatic acid, in the form of gas, deserved the preference, for the following reasons:—1st, From its being a permanently elastic fluid, it was much more diffusible than the vapour of nitrous acid—and, 2ndly, from the facility with which it destroyed the contagion of small-pox in the most concentrated state, I had little doubt of its efficacy in eradicating contagions in general. I then mentioned the experiments with small-pox matter, which are related in the first edition of Dr. Rollo's Treatise on Diabetes *. How the Doctor could confound this gas with the vapour of nitrous acid, with which at that time I had made no trials, it is difficult to conceive; but however this may be, it is necessary the mistake should be corrected: for, although it be possible, and even probable, that nitrous vapour may destroy the contagion of small-pox, yet it should never be admitted as a fact until proper and satisfactory experiments have been made. In the same conversation I mentioned the method now employed at Woolwich for fumigating with the sulphurous acid, and which we supposed had some advantages over that usually practised. It consists in mixing intimately two or three parts of pulverised sulphur with one of nitre; a certain quantity of this mixture, proportioned to the size of the apartment, is to be introduced into an iron pot,

* Mr. Cruickshank, in March 1795, took two portions of recent small-pox matter from the same person, and exposed one portion to this gas (the ox. mur. acid gas) for a few minutes, and with it inoculated the left arms of three drummers, while the right arms were inoculated with some of the other portion. The punctures of the left arms had no marks of inflammation, except what simple puncture produces, and they entirely disappeared in a few days. But the right arms took on the variolous action, and in two of the persons there was a general eruption. This experiment has been since repeated, and with the same success. *Rollo on the Diabetes Mellitus*, vol. i. p. 61.

and placed upon some bricks, or wet sand, in the middle of the floor. After the people have been removed, and the windows, &c. closely shut, the composition is to be set on fire by a live coal. During the combustion a great quantity of sulphurous acid gas, mixed with sulphuric acid in the state of vapour, is disengaged, and concentrated to such a degree as to force its way into the smallest apertures.

In the common method of burning sulphur it is impossible to concentrate the sulphurous acid in this manner, as the combustion ceases when the pure air in the room, &c. is nearly consumed; but in this case the oxygene is supplied by the nitre, and, the combustion being carried on with great rapidity, a prodigious quantity of gas, &c. is disengaged in a very short space of time.—It is true that this mode of fumigation cannot be put in practice while the patients are present: we doubt much, however, if the same objection is not applicable to any other, which shall be completely effectual in every case; for, to prevent the generation and spreading of contagion, is a very different thing from entirely eradicating it, after it has been produced, and attached to the clothing, furniture, &c.

The process for disengaging the oxygenated muriatic acid gas, in wards containing offensive sores and infectious diseases, is also extremely simple:—Four ounces of common salt, intimately mixed with two ounces of pulverised manganese, are introduced into a cup or small bason; to this mixture about two ounces of water are first added, and afterwards three ounces of the concentrated sulphuric acid in small portions at a time, each portion being sufficient to disengage such a quantity of gas as can be borne with ease by the patients in the room: when managed in this way, the smell of the gas is far from being offensive, and its effects in removing putrid and disagreeable smells much superior to any other means we have ever tried. (See the note, p. 397.) We do not, however, by any means deny the efficacy of the nitrous vapour: our principal objection to it, arises only from its ready condensation,

and

and the difficulty of diffusing it completely. But there is one circumstance on which the Doctor appears to place some reliance, the truth of which we very much doubt, and that is, that, during the disengagement of the vapour of the nitrous acid, a considerable quantity of pure air, or oxygene gas, is at the same time let loose; an opinion which is likewise supported by Mr. Keir. Now, from the generally received theory respecting the difference between the white and orange-coloured vapour, (and it is the last which is almost uniformly generated in close vessels, or where pure air is excluded,) a quite opposite effect should take place, that is, the production of the white vapour should be accompanied by a diminution of the oxygene gas in the room or apartment. In order to satisfy myself with regard to this fact, I made several experiments, the results of which were, that, when a cup containing a mixture of heated nitre and concentrated sulphuric acid was placed under a glass jar inverted over water, the air in the jar, after the nitrous vapour had been condensed, was found to have the proportion of its oxygene somewhat diminished, the difference being nearly as 93 to 90, or 31 to 30. This difference, which could not be perceptible in a large chamber, having only the usual quantity of nitrous vapour diffused through it, is but small, and I confess much less than was expected: it proves, however, that no oxygene gas is disengaged. In these trials the jar, after some time, was filled with orange-coloured vapours; and this never failed to be the case, where the heat of the materials, and strength of the sulphuric acid, were sufficient to disengage any quantity of nitrous acid. In the distillation of this acid, it is true, that a little pure air is disengaged towards the end; but this never happens until the bottom of the retort becomes red, and then the acid itself is decomposed, which can never take place in Dr. Smyth's process.

By giving a place to the preceding remarks in your valuable Magazine, you will greatly oblige

Yours, &c. &c.

Woolwich, May 12th, 1799.

W. Cruickshank.

XI. *Report made to the French National Institute, by* C. GUYTON *and* DARCET, *in regard to the Results of the Experiments of* C. CLOUET, *on the different States of Iron, and the Conversion of it into Cast Steel. From the* Journal des Mines, *No. XLV.*

THE memoir of C. Clouet is entitled Results of Experiments on the different States of Iron. He first treats of the combinations of iron and carbon. A thirty-second part of carbon, says he, is sufficient to convert iron into steel: a quantity of it equal to a sixth part of the weight of the iron, gives a steel more fusible and still malleable; but beyond that term it approaches to cast-iron, and has no longer sufficient tenacity. By increasing the dose of carbon you increase the fusibility, and it passes at length to the state of grey cast iron.

The particular kind of cast iron resulting from a combination of iron and glass, is the second object which engages the attention of C. Clouet. Glass never enters into it but in a very small quantity, yet its properties are changed. This iron, though exceedingly soft under the file, when brought only to a cherry-red heat, divides itself under the hammer; when poured into the ingot-mould, shrinks considerably; and when formed into plates, tempering gives them the grain of steel, and renders them more brittle, without giving them more hardness. Charcoal dust added to glass changes the result, and increases the fusibility; but the dose has a sensible influence on the products. From a thirtieth to a twentieth in one part of iron gives a very hard tempered steel, which suffers itself to be forged at a cherry-red heat, and which has all the properties of cast steel. By employing more carbon, you get only cast iron.

The affinity of iron for carbon is so great, that at a high degree of temperature it even takes it from carbonic acid. This he proves by the following experiment:—If you put into a crucible a crucible iron cut into ſmall pieces, along with a mixture of equal parts of carbonat of lime and argil, expoſe them to the degree of heat neceſſary to weld iron, and maintain this heat for an hour or more, according to the ſize of the crucible; the metal when poured into the ingot-mould will be ſteel ſimilar to caſt ſteel.

The oxyds of iron are equally ſuſceptible of paſſing to a ſtate of ſoft iron, ſteel, and caſt iron, according to the proportions of carbon employed. The black oxyd of iron, the ſtate of which ſeems to be the moſt unalterable, becomes iron when treated in the crucible with an equal volume of charcoal powder: by doubling that quantity you will have ſteel, and a progreſſive augmentation gives it the characters of white and grey caſt iron. In a word, C. Clouet obſerved the ſame tranſitions, and always depending on the reſpective quantities in treating caſt iron and the oxyd of iron, caſt iron and forged iron, the oxyd of iron and iron, the oxyd of iron and ſteel. A fifth part only of caſt iron is neceſſary to render iron ſteel. The iron and the oxyd do not unite intimately; the black oxyd mixed with a half leſs of carbon than is neceſſary for its reduction, gives a ſoft iron, but not very tenacious, black and without a granulated fracture. A ſixth part of the oxyd brings back common ſteel to the ſtate of iron, by treating them together either in the forge or by cementation.

At the end of his memoir C. Clouet gives ſome obſervations on the method of producing caſt ſteel, and the furnaces proper for that purpoſe. He determines the proportions of the ſubſtances to be fuſed; the degree of heat; the precautions to be employed in pouring them into the ingot-mould; the method of forging this kind of ſteel; the proceſſes to be employed for aſſays, in a common forge, upon three or four pounds of matter; and the proportions to be given to a reverberating furnace to operate at the ſame time with four crucibles, containing each from twenty-three to twenty-ſix pounds of ſteel. He remarks, that ingredients of ſaline glaſs cannot be employed with advantage; that glaſs, too fuſible, renders ſteel difficult to be forged; that ſteel kept a long time in fuſion, takes up more glaſs than it ought; and laſtly, that the metal muſt be ſtirred, and the glaſs taken carefully away before it is poured out, in order that it may not mix itſelf with the ſteel. After giving a ſhort view of the obſervations of C. Clouet, and the practical conſequences which he deduces from them, it would have remained for us only to lay before you ſome ſpecimens produced by his operations, had we not thought it our duty to add the reſults of the experiments which we made ourſelves, by following his proceſſes for the immediate converſion of iron into caſt ſteel, and of which it is of importance that we ſhould deſcribe the principal circumſtances.

The members of the Council of Mines having permitted us to make uſe of the forge conſtructed in their laboratory, we put into a luted Heſſian crucible 6 hectogrammes (1·23 lb.) of the points of horſe-ſhoe nails, and 4 (·81 lb.) of a mixture of equal parts of the carbonat of lime (white marble) and burnt clay, from a Heſſian crucible, all reduced to powder. The mixture was heaped up to ſurround the iron fragments on every ſide; and the crucible placed upon its ſtand in the middle of the furnace, the heat of which was urged by three blaſts. In our firſt trial we found, after about an hour and a half, that the matter was fuſed; but the crucible having burſt, we were prevented from pouring it out. On repeating the operation at the ſame forge, and in the ſame manner, we obtained an ingot; a portion of which we now ſubmit to the inſpection of the Claſs. It forms a ſquare bar, each face of which is from 26 to 27 millimetres (about one inch Engliſh).

The frequent and almoſt unavoidable accidents which crucibles experience by being expoſed to the blaſt of bellows, made us think it a point of importance to aſcertain whether the operation would ſucceed equally well in a reverberating furnace or any other wind furnace, as C. Clouet announces.

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We first employed a Macquer's furnace in one of the laboratories of the Polytechnic School. Though its state of derangement did not give us reason to hope for the whole effect of the principles of its construction, a pyrometric piece placed in a separate crucible indicated that the heat had been carried to 151 degrees. The crucible did not appear to be either broken or cracked; yet the fusion was incomplete, and even a portion of the iron remained uncovered above the portion of the vitreous mass, without it being possible to discover the cause.

We then resolved to repeat the experiment at a founder's furnace; and C. Lecour, assayer of the mint, was so kind as to permit us to operate with that in his laboratory. Our success exceeded what we expected, considering the size of the furnace. A particular description of this operation appeared to us the best means of satisfying the demand of government, since it tends to establish the possibility of a manufactory of this kind on a large scale, and to give from observation the basis of this new art.

We repaired to the laboratory of C. Lecour in the mint, with our colleague Vauquelin, who assisted us in our experiments. The wind furnace is constructed of brick. The fire-place *a* is a square cavity of 25 centimetres (9·23 inches) on each internal face, 45 centimetres (16·62 inches) in height, terminated at the bottom by a grate *b* of seven square bars 27 millimetres (one inch) in thickness, and raised 25 centimetres (9·23 inches) above the bottom of the ash-hole. The mouth has an iron cover *c*, with hinges inclined about 25 degrees (see Plate IX.) from a perpendicular. The tunnel *dd*, by which the furnace is terminated, is built of bricks also. It commences above the aperture of the cover, and first forms a square, each face of which internally is equal to 25 centimetres; but it becomes narrower as it ascends, so that each face at the extremity is a fifth less. This tunnel rises, inclined against the wall, to the height of 13 decimetres (about four feet.) It is there connected with a large chimney raised about 15 metres (or 45 feet), the excefs in the width of which is clofed by a trap *e* moving on hinges when the furnace is at work. We had previoufly put into a Heffian crucible 15 centimetres (about 5½ inches) in height, and 8 in diameter, 367 grammes (6914 grains) of fmall iron nails, and 245 grammes (4616 grains) of a mixture of carbonat of lime and burnt clay. This crucible was placed on its ftand in the middle of the furnace.

At one of the corners of the bottom was placed a fmall crucible of kaolin with its cover, and containing two of Wedgewood's pyrometrical pieces, taken from two different boxes. We readily forefaw that in this pofition they would not receive the fame degree of heat as the crucible placed in the centre; but it was a mode of eftimation not to be neglected. The fire was kindled about half an hour after ten, and urged at firft very flowly. At one o'clock we judged the fufion to be complete, took away the vitreous part, and poured the matter into the ingot-mould. A part of the matter remained fixed in the crucible, becaufe too much time was employed in removing the laft portions of the glafs, and becaufe perhaps a quarter of an hour more heat would have been neceffary; but the moulded portion, by its form and grain, left no doubt of proper fufion, and of its perfect converfion into fteel. The pyrometric pieces, placed at the corner of the furnace, gave one 136 degrees, and the other 140; from which it may be inferred, that the matter in the large crucible was expofed to a heat of about 150 degrees.

" Caft fteel," fays Perret in his Memoir which obtained the prize from the Society of Arts at Geneva, " is judged by moft fmiths intractable; but it is ftill poffible to overcome it by attention and addrefs." That of C. Clouet requires the fame precautions, which depend on its peculiar nature; and it affords a proof that it may be forged, and that in this ftate, even though its grain be not rendered finer by tempering, it will bear a comparifon with the Englifh caft fteel. We fubjected alfo to trial, by forging, a fmall piece obtained

obtained by fuſion in a wind furnace: the grain of its fracture, after having been forged, fully confirmed the opinion which we formed of it when caſt.

The ingots almoſt always exhibit on their fracture ſmall cavities, which it might be ſuppoſed would produce faults in the forging; but as they are clear and free from all foreign matter, they form no obſtacle to the union of all the parts. Beſides, it will be eaſy to prevent this accident by a ſlower cooling in the ingot mould, which will naturally take place in operating upon larger maſſes. We ought not to omit that this ſteel, when forged into bars, is exactly in that ſtate which Rinman indicates as one of the characters of caſt ſteel. Its ſpecific gravity is to that of the fineſt ſteel, not caſt, in the proportion of 7·917 to 7·79.

However concluſive theſe reſults may be, it appears that ſomething would ſtill be wanting, if we did not at the ſame time produce a ſpecimen of what an able hand, accuſtomed to manage the Engliſh caſt ſteel, can do with ours in the fabrication of thoſe inſtruments to which Engliſh ſteel gives ſo much ſuperiority: we have the ſatisfaction of being able to exhibit this proof alſo of the utility of C. Clouet's diſcovery.

A bar of ſteel ariſing from the caſt made at the *Depôt des Machines du Conſervatoire*, was delivered by C. Molard to C. Lepetitwalle, proprietor of the national manufactory of ſteel razors at the *Quinze-vingts, faubourg Antoine.* He made of it three razors, viz. two without any preparation, and one after having taken away the *apperçus* (the name given to the ſmall fiſſures found at the ſurface and on the edges). This artiſt declares, that "the latter was manufactured with great facility, conſidering the quality of the metal; that it will bear compariſon with thoſe of the fine Engliſh ſteel named Marſchall and B. Huntzman; and that all the three are excellent for any beard whatever."

Hitherto we have confined ourſelves to an examination of the proceſſes and productions which have more particularly attracted the attention of Government; but we cannot terminate this report without pointing out, in a few words, the truths of the theory ariſing from them. It is well known that iron does not become ſteel, but by aſſuming about 0·2013 of its weight of carbon: here it is furniſhed only in the ſtate of carbonic acid; this acid then is decompoſed. This is a very important phenomenon, which the obſervation of C. Clouet has added to the proofs of the doctrine of the French chemiſts. But how is this decompoſition effected?—It evidently reſults from the eventual or prediſpoſing affinity which a portion of the iron exerciſes upon the oxygen of the acid, at the ſame time that the remainder of the iron tends to unite itſelf with the carbon; and a concurrence of theſe attractions produces a reſult which one would not have expected, and which would not indeed have been poſſible by ſimple affinity. Thus in this operation the vitreous flux is always ſeen charged with the oxyd of iron, the preſence of which diſcovers itſelf by a very dark green colour. The experiment in which the iron was not fuſed, has enabled us to exhibit to you a proof of it. Hence it might perhaps be inferred, that this indiſpenſible oxydation of a portion of the iron occaſions in the product a decreaſe of ſo much the more importance, as iron only of the beſt quality can be employed in the operation. This conſideration made us pay attention to the decreaſe, in order that we might at leaſt give ſome idea of its probable limits. In the operation conducted at the wind furnace, the decreaſe was not altogether a twelfth; in another experiment made at the forge of the School of Mines, before C. Vauquelin, in 428 grammes of iron there was a loſs only of 19 grammes, that is to ſay, leſs than a twenty-ſecond part. We may then reſt aſſured that this loſs will be compenſated by the value which the reſt of the matter will acquire; and that, inſtead of increaſing, it muſt be diminiſhed when working on a large ſcale, for it is evident

evident that it is produced chiefly by an accidental scorification, and always more in proportion to the surface than to the mass.

It now remains that we should still make, in regard to the process itself, a remark which seems proper to shew the superiority of it to all those hitherto used for the conversion of iron into steel. It is well known that the great difficulty is to make it take up the proper dose of carbon; below that you have soft steel; and above it, steel supersaturated almost to the state of cast iron, and as refractory. Ought not the quantity to be determined here by the concurrence of the forces of the affinity which operate the decomposition of the carbonic acid? The degree of saturation would be then constant, and the product always uniform; and it may be readily comprehended how much value this condition, which we mention only as probable, would add to the new method.

From these reflections, and the facts mentioned in this report, we conclude, that the observations of C. Clouet on the different states of iron diffuse a new light over the manner of treating this metal; that the immediate conversion of soft iron into cast steel, without employing carbon, and by the decomposition of the carbonic acid, is a discovery as important for the advancement of the theory of chemical affinities, as it is valuable for increasing national industry; that, by the labours of C. Clouet, the processes of this new art are already determined, in such a manner as to leave no doubt of their succeeding in a large manufactory; that the steel arising from them, when forged in bars, has all the external characters and intrinsic qualities of the English cast steel of the manufactories of Huntzman and Marschall; that it may be used for the same purposes, and be introduced in competition with it into commerce, without fear of any distinction being made to its prejudice; that it is to be wished, in order to hasten the benefits of this discovery, that government would order from 15 to 20 myriagrammes to be manufactured of this steel, the value of which, at the present

 price,

price, would be almoſt equivalent to the expence; that entruſting the management of the firſt trials to C. Clouet, would enſure the beſt ſucceſs; and laſtly, that, in any event, the free and unreſerved communication which C. Clouet has made of this diſcovery, entitles him to the gratitude of his countrymen, and to a national reward.

XII. *Extract of a Report made by* C. Pictet, *of Geneva, to the Society for the Advancement of the Arts eſtabliſhed in that City in regard to the Steel-Yards of* C. Paul. *From the* Journal des Mines, *No. XLV.*

THE place of inſpector of weights and meaſures, occupied at Geneva by C. Paul, having given him an opportunity of carefully examining a great number of ſteel-yards, he has found reaſon to be convinced that the greater part of theſe inſtruments, and particularly the Roman ſteel-yards, are conſtructed on bad principles, and ſeem to have been made by artiſts unacquainted with the properties of the lever. He has ſucceeded in improving theſe inſtruments, and ſteel-yards in particular. The latter, in the common purpoſes of commerce, have two advantages over balances. 1. That their axis of ſuſpenſion is not loaded with any other weight than that of the merchandiſe, the conſtant weight of the apparatus itſelf excepted; while the axis of the balance, beſides the weight of the inſtrument, ſuſtains a weight double to that of the merchandiſe. 2. The uſe of the balance requires a conſiderable aſſortment of weights, which cauſes a proportional increaſe in the price of the apparatus, independently of the chances of error which it multiplies, and of the time employed in producing an equilibrium. Theſe motives induced C. Paul to employ his thoughts on the means of ſo far improving ſteel-yards, that, either in delicate operations of the arts, or in thoſe of the ſame kind which are often ſo neceſſary in the practice of the phyſical ſciences, theſe inſtruments ftruments might be fubftituted with advantage for common balances. In order that I may better explain in what the improvements of the fteel-yards fubmitted to the Society confift, it will be proper to point out what were the faults of the common ones.

1. There were none of them, in which the points of fuf-penfion were exactly in the prolongation of the line of the divifions of the beam; a circumftance which neceffarily changed the relation between the arms of the lever, the power and the refiftance, according as the direction of the beam was changed from a horizontal pofition. We have feen fteel-yards, in which a degree only of difference in the inclination of the beam produced the difference of more than a pound in the refult.

2. When the fhell, the beam, and weight, are made at hazard, a perfon who poffeffes a fteel-yard cannot know when the inftrument is deranged; and even an artift cannot repair it, but by repeated trials, and with a great lofs of time.

3. The conftruction of the common fteel-yards, which have a fmall and a large fide, renders it neceffary to invert them frequently: a laborious operation when thefe inftruments are heavy, and which expofes the axes to the danger of damage by the effect of the fhocks which that turning occafions.

As thefe double fides renders it neceffary to have a beam very ftraight, in order that it may be lefs faulty, it readily bends, which is a new fource of error; and, the face which bears the numbers being narrow in proportion, it is difficult to form on it numbers fufficiently vifible. Thefe inconveniences are all avoided by the conftruction of C. Paul, which prefents, befides, feveral other advantages not poffeffed by the old fteel-yards.

1. The centres of the movement of fufpenfion, or the two conftant centres, are placed on the exact line of the divifions of the beam; an elevation almoft imperceptible in the axis of the

the beam, destined to compensate for the very slight flexion of the bar, alone excepted.

2. The apparatus, by the construction of the beam, is balanced below its centre of motion; so that when no weight is suspended, the beam naturally remains horizontal, and resumes that position when removed from it, as also when the steel-yard is loaded and the weight is at the division, which ought to shew how much the merchandise weighs. The horizontal situation in this steel-yard, as well as in the others, is known by means of the tongue, which rises vertically above the axis of suspension.

3. It may be discovered that the steel-yard is deranged, if, when not loaded, the beam does not remain horizontal.

4. The advantage of a great and a small side (which in the others augments the extent of their power of weighing) is supplied by a very simple process, which accomplishes the same end with some additional advantages. This process is to employ, on the same division, different weights. The numbers of the divisions on the bar, point out the degree of heaviness expressed by the corresponding weights. For example, when the large weight of the large steel-yard weighs eighteen pounds, each division it passes over on the bar is equivalent to a pound; the small weight, weighing eighteen times less than the large one, will represent, on each of these divisions, the eighteenth part of a pound or ounce; and the opposite face of the bar is marked by pounds at each eighteenth division. In this construction, therefore, we have the advantage of being able, by employing both weights at once, to ascertain, for example, almost within an ounce, the weight of 500 pounds of merchandise. It will be sufficient to add what is indicated by the small weight in ounces, to that of the large one in pounds, after an equilibrium has been obtained by the position of the two weights, viz. the large one placed at the next pound below its real weight, and the small one at the division which determines the number of ounces to be added.

5. As

5. As the beam is divided only on one ſide, it may have the form of a thin bar, which renders it much leſs ſuſceptible of being bent by the action of the weight, and affords room for making the figures more viſible on both the faces.

6. In theſe ſteel-yards the diſpoſition of the axes is not only ſuch that the beam repreſents a mathematical lever without weight; but in the principle of its diviſion, the interval between every two diviſions is a determined and aliquot part of the diſtance between the two fixed points of ſuſpenſion; and each of the two weights employed has for its abſolute weight the unity of the weight it repreſents, multiplied by the number of the diviſions contained in the interval between the two conſtant centres of motion. Thus, ſuppoſing the arms of the ſteel-yard divided in ſuch a manner that ten diviſions are exactly contained in the diſtance between the two conſtant centres of motion, a weight to expreſs the pounds on each diviſion of the beam muſt really weigh ten pounds; that to point out the ounces on the ſame diviſions, muſt weigh ten ounces, &c. So that the ſame ſteel-yard may be adapted to any ſyſtem of meaſures whatever, and in particular to the decimal ſyſtem, by varying the abſolute heavineſs of the weights, and their relation with each other. The application of this principle will be ſeen hereafter in the deſcription of the ſteel-yard, to which C. Paul, with great propriety, has given the name of *univerſal ſteel-yard*.

But, to trace out, in a few words, the advantages of the ſteel-yards conſtructed by C. Paul for commercial purpoſes, I ſhall only obſerve, 1. That the buyer and ſeller are certain of the correctneſs of the inſtrument, if the beam remains horizontal when it is unloaded and in its uſual poſition. 2. That theſe ſteel-yards have one ſuſpenſion leſs than the old ones, and are ſo much more ſimple. 3. That by theſe means we obtain, with the greateſt facility, by employing two weights, the exact weight of merchandiſe, with all the approximation that can be deſired, and even with a greater preciſion precifion than that given by common balances. There are few of thefe which, when loaded with 500 pounds at each end, are decidedly fenfible of an ounce; and the fteel-yards of C. Paul poffefs that advantage, and coft one half lefs than balances of equal force. 4. In the laft place we may verify, every moment, the juftnefs of the weights, by the tranfpofition which their ratio to each other will permit; for example, by obferving whether, when the weight of one pound is brought back one divifion, and the weight of one ounce carried forwards eighteen divifions, the equilibrium ftill remains.

If, inftead of afcertaining the weight of the merchandife in pounds, you wifhed to find it according to the new fyftem in decagrammes, hectogrammes and kilogrammes, it will be fufficient to fubftitute, for the ordinary weights, an affortment of three weights bearing the above names. Thefe three weights are the decuple one of the other; and the abfolute weight of that called kilogramme, is to the abfolute weight of that called pound, in the exact ratio of thefe two quantities. It may be here feen, that, by adapting to the fteel-yard a fyftem of three weights, we may arrive at the fecond decimal, or the centiemes of the unity of the weights employed, and even without adding or changing any thing in the divifion of the beam.

It is on this fimple and advantageous principle that C. Paul has conftructed his *univerfal fteel-yard*, which I am going to defcribe. It ferves for weighing in the ufual manner, and according to any fyftem of weights, all ponderable bodies to the precifion of half a grain in the weight of a hundred ounces; that is to fay, of a decigramme in the weight of a kilogramme, or, in other words, of a ten thoufandth part.

It is employed, befides, for afcertaining the fpecific gravity of folids, of liquids, and even of the air itfelf, by proceffes extremely fimple, and which do not require many fub-divifions in the weights. This complete apparatus is reprefented plate X.

The

The beam A B of this ſteel-yard is conſtructed on the ſame principles as the commercial ſteel-yard, but of much ſmaller dimenſions *. The ſhears are ſuſpended by a ſcrew to a croſs bar of wood ſupported by two pillars, which reſt on the two extremities of a ſmall wooden box furniſhed with three drawers, and which ſerves as the ſtand of the apparatus. This beam is divided into 200 parts, beginning at its centre of motion. The diviſion is differently marked on the two faces: on the anterior face the numbers follow each other from 10 to 200, proceeding towards the extremity; and on the other face, repreſented apart at F, the numbers are marked in the oppoſite direction. I ſhall ſoon explain the uſe of this difference in the order of numeration.

The ſmall frame G is deſtined to prevent the oſcillation of the beam, and it is placed at the proper height by means of the nut and ſcrew by which it is ſuſpended. Above the beam is ſeen a ſmall croſs bar of braſs, ſuſpended by its two extremities from the croſs bar of wood. Different weights are hooked to it, each having its particular value marked on it. And, in the laſt place, a ſmall mercurial thermometer having the two moſt uſual diviſions, and deſtined to point out the temperature of the air and the water during the experiments. The axis of ſuſpenſion of the ſteel-yard reſts upon two beds of very hard well-poliſhed ſteel. The caſe is the ſame, but in a reverſed ſituation, with the axis which ſupports the hook C, that ſerves for ſuſpending different parts of the apparatus according to the purpoſe to which it is to be applied.

When you wiſh to employ it as a common ſteel-yard, you ſuſpend from it the braſs ſhell E, which is an exact counterbalance for the weight of the beam when unloaded. The latter

* A drawing of C. Paul's Commercial Steel-yard was ſubjoined to this memoir. As it was impoſſible to give more plates, we have been obliged to ſuppreſs that figure; but the one we have cauſed to be engraved will give a very correct idea of it, ſince the principles of the conſtruction of both the large and ſmall ſteel-yards are abſolutely the ſame. *Note of the French Editor.*

latter then assumes of itself a horizontal situation. You then search for the equilibrium of the substance put into this shell, by placing at the proper place, on the beam, the weight and its fractious corresponding with the system of weights adopted; and when you have found the equilibrium, you observe the weight indicated by the divisions on which each of the weights employed is found, exactly in the same manner as is done in regard to the common steel-yard.

There may be seen in the plate a glass shell suspended in a jar filled to a certain height with water. This shell is destined for experiments in regard to the specific gravity of solids. It is in equilibrium, if, when immersed into water at 12° R, as far as the junction of the three silver wires by which it is supported, it exactly balances the weight of the beam unloaded.

When you wish then to try the specific gravity of a solid, you first weigh it in air; but by putting it into the brass shell, and then substituting the glass one, you weigh it in water. It is well known that the difference of these weights, employed as a divisor of the total weight in air, gives for quotient the specific gravity. Care must be taken, as in all experiments of the kind, that no bubble of air adheres to that part of the apparatus immersed in the water, or to the substance, the weight of which is required, and which is immersed also.

The solid glass ball H is destined for the purpose of ascertaining the specific gravity of liquids, in the following manner:—This piece is furnished with a hook of fine gold, that it may be immersed without inconvenience in acids. When it is suspended to the hook of the steel-yard, and in the air, it is in equilibrium with the beam loaded at its extremity (either at the division marked O, on the side of the beam seen at F) with weights entitled *specific*, and $\frac{1}{100}$ of specific hooked on at the other.

This ball, immersed in distilled water at 12° R. as far as the end of the straight metal wire which suspends it, is still in equilibrium with these two weights placed in the following manner, viz. the large one at the division in the middle of the

the beam marked *water* on the fide F of the beam, and the fmall one at the divifion O, that is to fay, the extremity. When the apparatus is thus prepared, you fill a jar with the liquid, the fpecific gravity of which you wifh to afcertain; fufpend the *ball* H to the hook of the fteel-yard, and immerfe it into the liquid till it rife exactly above the ring from which the ball hangs, obferving the temperature, and difengaging carefully all the air bubbles that may adhere to the ball; then remove the fmall weight to the divifion O at the end of the beam, and convey the large one as far as that divifion, preceding that where the weight of the ball would raife the beam; and afterwards move the fmall weight as far as the divifion where the equilibrium will be reftored, the beam being horizontal. Mark the divifion at which the large weight is found, and add two cyphers; to this number add the indication immediately refulting from the pofition of the fmall weight, and the fum of thefe two numbers gives the fpecific gravity of the liquid, or its ratio with the weight of diftilled water to a ten thoufandth part.

The balloon N is deftined for trying the weight of any given kind of gas compared with that of atmofpheric air, in the following manner:—The weight entitled *air ture* is arranged in fuch a manner that when placed in the notch, feen at the extremity of the beam beyond the divifions towards B, it forms an equilibrium with the balloon exhaufted by the air-pump and fufpended from the hook of the fteel-yard. If the fteel-yard is not then in equilibrium, it is a fign that the inftrument is deranged, or that the vacuum is not perfect. The air, the relative weight of which in regard to atmofpheric air you wifh to afcertain, is to be introduced into the balloon, and the weight marked *air* is to be moved along the beam. The divifion at which it ftands when an equilibrium is produced will indicate, in hundredth parts of the weight of the volume of atmofpheric air that could be contained in the balloon, the weight of the gas actually inclofed in it. This

This indication is read on the anterior part of the beam, where the words *atmofpheric air* are marked.

Not fatisfied with having procured to philofophers, and thofe fond of accurate experiments, an inftrument extremely convenient for the clofet, and of very extenfive ufe, C. Paul has endeavoured to render this apparatus portable, and has conftructed various pocket fteel-yards, with which the niceft experiments may be made, and the quality of gold coin be afcertained by the trial of its fpecific gravity. They are conftructed exactly on the fame principles as the Roman fmall fteel-yard, but are neceffarily lefs extenfive in their ufe. They cannot be employed, for example, in determining the fpecific gravity of an aëriform fluid, and do not extend beyond 100 deniers of weight, (about 120 grammes;) but as they poffefs all the advantages of a balance, befides thofe peculiar to themfelves, they are extremely convenient for philofophers who are obliged to travel.

EXPLANATION OF THE PLATE.

A, B, the beam of C. Paul's fteel-yard with its divifions, commencing at the point of fufpenfion. F, divifion of the other fide of the fame beam, commencing at the other extremity, or that fartheft diftant from the point of fufpenfion. G, a fmall frame deftined to prevent the ofcillation of the beam. C, a hook from which the weights are fufpended. E, a brafs fhell or bafon. H, a ball of folid glafs for trying the fpecific gravity of liquids. N, a glafs balloon for trying the fpecific gravity of gafes.

XIII. *A new, eafy, and cheap Method of impregnating Water with Carbonic Acid Gas. Communicated by Dr.* A. N. SCHERER, *Counfellor of Mines to the Duke of Saxe Weimar.*

DR. FIERLINGER has propofed the following very fimple method for impregnating water with carbonic acid gas.

gas. He fills common round bottles with water, inverts them carefully under water in order to prevent any air from entering, and charges them in the usual method with carbonic acid gas. He then corks the bottles, thus filled, under the water, with a ventilated stopper, immerses them under water in a proper cylindrical, almost tubular shaped vessel, 2 feet high, and of a proportionate width to the diameter of the bottle, in order to apply, by means of hydrostatic laws, a great pressure with a small quantity of water. The bottles thus filled with the gas, and entirely immersed, imbibe water by means of the affinity the carbonic acid gas has for it, in such a manner that they are nearly filled; and water is thereby obtained, impregnated with an equal volume of gas, the water having lodged itself in the interstices of the gas. It is pretty strong, and can be made still more so. This method has, besides its conveniency and cheapness, still other advantages; the degree of impregnation may be regulated by the height of the column of water under which the bottle is immersed, and the water is prepared in those vessels out of which it is to be drank, and this prevents that escape of gas which always takes place when poured from one vessel to another, especially if the water be strongly impregnated. The above-mentioned ventilated stoppers are corks fitted exactly to the bottles, perforated length-ways, by holes drilled through them, the uppermost orifices of which are covered with a small plate of pewter, fastened to the cork by means of a string passed through a hole in the centre, and drawn through the cork. If this small plate be furnished with a little cavity, in which iron filings are put, the water becomes chalybeate.

XIV. *Fifth*

XIV. *Fifth Communication from Dr.* THORNTON, *Phyſician to the General Diſpenſary, relative to Pneumatic Medicine.*

A CASE OF ST. ANTONY'S FIRE CURED BY VITAL AIR.

MISS GOUDY, æt. 18, living No. 171, High-ſtreet, Shadwell, had been ſubject to occaſional attacks of this diſeaſe for eight years paſt. In one attack, ſome years ago, a ſkin formed over the right eye, which was removed by a cauſtic powder blown into it by order of Mr. Sharp, and ſight was reſtored in about a month: this eye has, however, ſince been ſubject to become inflamed upon the leaſt cold, when the face enlarges prodigiouſly, looks red as fire, with intenſe burning. She had taken a great quantity of medicine under Meſſrs. Young, Ward, Evans, &c. without any marked advantage, previous to her parents making application to me. When I ſaw her, her right eye was much inflamed, and the upper lips and cheeks were tumefied in a frightful degree. It was a new caſe, that required much conſideration. Were the veſſels in a ſtate of inflammation from tone, or from debility? Examining the arms I found them remarkably blue and mottled, the feet were always uncommonly cold, the appetite craving, or elſe none, very flatulent, great diſtention of the abdomen at times, and a tendency to chloroſis. The pulſe ſmall, and quick. I accordingly ordered the ſuper-oxygenated air, November 27, 1798, gradually augmenting its power. Memorandum—December 4, Feels always a great glow over the whole body, after inhaling the vital air. Inflammation of the eye gone. I ordered a ſeton in the neck, to hinder a relapſe, by its inviting the blood to a neighbouring part, and ſetting up a new action: and without fear I now purſued the tonic and ſtimulant plan, viz. bark, myrrh, and ſteel, and a ſuper-oxygenated air *; and my fair patient was ſoon perfectly cured, and continues ſo, I am happy to ſay, to this day.

* The proportion was generally ſix quarts vital air mixed with twenty of atmoſpheric.

INTEL-

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

GERMANY.

THE following queſtion has been propoſed as the ſubject of a prize by the Royal Society of Gottingen, to be anſwered before the firſt of November 1800.

As it has been aſcertained by numerous experiments that a great quantity of vaporific *(caloris vaporifici)*, or, as it is called, latent heat, is carried off by the ſteam of water, boiling in an open veſſel, and ſoon diſperſed, which, however, if carefully collected through tubes and pipes properly diſpoſed, might be of great utility in various purpoſes in economy and manufactures, the Society embraces this opportunity of requeſting mathematicians and philoſophers to turn their attention to this ſubject, and to endeavour, as far as poſſible, to eſtabliſh a more accurate theory than any yet given of the motion of ſteam.

The Royal Society requires, therefore, I. An inveſtigation, both by experiment and calculation, of the laws, or at leaſt the general laws, of the ſteam of boiling water paſſing through tubes of a certain length and ſize; the matter of the tubes and the degree of heat of the ſurrounding medium being given, as well as other data which it is not neceſſary to mention to thoſe acquainted with the nature of this elaſtic fluid.

II. When theſe laws are in ſome meaſure eſtabliſhed, to deduce from them what degree of heat can be communicated, in a given time, by a given quantity of ſteam thus conveyed through tubes, with a given quantity of cold water, or water of any given temperament.

The

The Electoral Jablownſki Society of the Sciences, at Leipſic, have propoſed the following queſtions, as the ſubject of a prize for the year 1799:

HISTORY. An explanation, proved by authentic documents, of the origin, rights and principal deſtination of the dignity of Earl in the northern kingdoms.

MATHEMATICS. A more accurate determination, compared with experience, of the laws of reſiſtance to fluid bodies impelling in an oblique direction.

PHYSICAL-ECONOMY. Application of our preſent knowledge reſpecting the different kinds of air, particularly to phyſics and economy.

The prize is a gold medal of the value of 24 ducats. No papers will be received but ſuch as are written in French or in Latin; and they muſt be accompanied with a ſealed note, containing the author's name and place of reſidence.

The following is an account of the Sittings of the Academy of Sciences of Berlin, in the year 1798:

On the 11th of January M. Selle read a German memoir on natural right; and on the 18th M. Erman read one in French on literary blunders, and their influence on biography.

In the public ſitting of Jan. 25th, M. Achard read, in French, an account of ſome experiments made with a view to determine the influence of compreſſed air on the germination of ſeeds, and its action on animal life, with the deſcription of a new method of injecting the veſſels of plants which are capable of receiving a fluid within them.—M. Denina read a French memoir on the ancient traces of the character of the Germans, followed by a ſhort compariſon between Marcus Aurelius and Frederic II.—M. Klaproth, a German memoir on the gold ore of Tranſylvania, and the new metal it contains.—M. Baſtide, Reſearches, in French, on the word *environ*.—Count de Guyon, an hiſtorical view, in French, of the influence which women have had over the great actions of their age and country. This formed the third epoch.

On the 1ſt of February M. Wildenow read, in German, an eſſay on a new claſſification of the *mammiferæ*.

On the 8th M. Bode communicated ſeveral articles of intelligence from his aſtronomical correſpondents. He preſented alſo a memoir on the orbit of the comet obſerved at Berlin in 1797, which contained ſome reſults reſpecting its real courſe.

On the 15th M. Caſtillhon, Reflections, in French, on the ſenſes in general, and particularly on the organs of the internal ſenſe.

On the 22d M. Gedike, a paper, in German, on the reciprocal influence of civiliſation on writing, and of writing on civiliſation.

On the 8th of March M. Burja communicated a paper, in French, on the progreſs of light paſſing through a tranſparent priſm, with an application to achromatic priſms, and achromatic teleſcopes.

On the 15th M. Ancillon preſented a French memoir on preſenſation.

On the 22d M. Baſtide preſented, in French alſo, various obſervations on the French language, in regard to different paſſages of Montaigne, with ſome critical remarks on that author.

On the 29th M. Walter, the ſon, read a German memoir on the ſkin.

On the 19th of April M. Bode preſented the eight firſt ſheets of his celeſtial chart.

On the 3d of May M. Teller preſented a paper, in German, on moral puriſm and empiriſm, and the ideas which ought to be formed of them.

On the 10th M. Cuhn, a paper, in German, on the hiſtory of the origin of the Germanic conſtitution.

On the 7th of June M. Achard, a German memoir, containing reſearches on the germination of ſeeds, and the growth of plants.

On the 14th M. Gruſon, a paper, in French, on a new calculus, which he calls *calcul d'expoſition*.

On the 21ſt M. Bieſter, a paper, in German, on the principle of Socrates, that virtue and knowledge (φρονησις et επιςημη) are the ſame thing.

On the 28th M. de Verdy, an hiſtorical chronology, in French, of the Margraves of Brandenbourg, Anſpach, and Bayreuth, deſcended from the electoral houſe of Brandenbourg, and who have exiſted ſince the year 1486 to the preſent time.

On the 2d of Auguſt M. Achard, a continuation of his experiments on the germination of ſeeds, &c.

On the 9th of the ſame month the academy held a public ſitting, in which the following papers were read:—M. Achard gave an account of the experiments he had made to determine the influence of the coloured rays of light on the germination of ſeeds, the green colour of plants and their decay, and alſo to aſcertain the different degrees of the affinity of oxygen with luminous rays differently coloured. He ſhewed, at the ſame time, the apparatus which he employed, as well as the reſults of his experiments.—M. Erman read a memoir on the order of ſucceſſion in the houſe of Pruſſia and Brandenbourg, ſince the reign of the branch of Hohenzollern.—Count de Guyon read the fourth period of his hiſtorical view of the influence of women on the great events of their age and country. The ſitting was terminated by a memoir of the marquis de Boufflers on literature and literary men.

HOLLAND.

The Batavian Economical Society, authoriſed by the Directory of the Batavian republic, has propoſed the following queſtion as the ſubject of a prize, to be anſwered either by natives or foreigners:

Are there any means hitherto unknown, and ſufficiently effective, to reſtore ſo completely, without the mixture of pernicious ingredients, the taſte and ſmell of ſtinking and corrupted water, as to render it a pure, cooling, and wholeſome beverage? And what are theſe means?

A ſatiſ-

A ſatisfactory anſwer to this queſtion will entitle the author to a prize of 6000 florins. In the anſwer care muſt be taken, 1ſt, That the means be not too expenſive, or attended with too much trouble; that they do not occaſion too great a conſumption of fuel; and that they can be employed at ſea, on board veſſels heavily laden, and often expoſed to violent agitation.—2d, That the means do not require too much art, and may be eaſily applied, even by ſeamen.—3d, That they be proved by experiments capable of producing the ſame effects in every temperature.—4th, That they be not hurtful, by corroding the copper veſſels in which ſhip's proviſions are boiled, or in any other manner.

If the inventor of ſuch means, after aſcertaining their effect, will communicate his ſecret, without concealing any part of it, to the commiſſioner of the Society, ſo that it may be ſubjected to trial in any determined place or ſhip, and if it ſhall be found to anſwer after ſeveral experiments, he will receive a third part of the premium. The reſt of the ſum will be paid as ſoon as the Society have been convinced of the certainty of the reſult of theſe means, by experiments made in different climates, and by the opinion of competent judges.

The Society, however, retains to itſelf a right of dividing the prize among ſeveral competitors, ſhould the means propoſed by each be equally efficacious.

The papers are to be tranſmitted, with the uſual formalities, addreſſed to C. J. J. Deſſout at Harlem, Secretary General to the Batavian Society, before the 28th of February 1800.

SWISSERLAND.

The Economical Society of Berne, having received no ſatisfactory paper on the means of extirpating a deſtructive kind of moth, common there, which not only attacks woollen but alſo ſilk, and is particularly deſtructive to furniture ſtuffed with horſe-hair, for which they offered a prize of 20 ducats in the years 1796 and 1797, again repeat the ſame queſtion, and extend the time for receiving anſwers to three years.

 The

The Society expect—1ſt, That the candidates will determine accurately whether this inſect be the *tinea veſtionella*, *pellionella*, *tapetzella*, or *ſarcitella* of Linnæus, or different from theſe.—2d, A circumſtantial natural hiſtory of it.—3d, An examination, founded on experience and ſcientific principles, of the efficacy of all the means hitherto propoſed for extirpating it.—And laſtly, A propoſal, founded on experience and trials made, of means by which the deſtruction occaſioned by theſe peſts may in future be prevented. Papers on this ſubject may be tranſmitted to the Society any time before the 1ſt of January 1802.

FRANCE.

In the public ſitting of the National Inſtitute on the 4th of January, the following report was read of the labours of the Claſs of the Phyſical Sciences during the preceding quarter.

Among the various objects which for three months have occupied the Claſs of the Phyſical Sciences, were two new kinds of plants preſented by C. Lheritier. The firſt, diſcovered at Madagaſcar by C. Bruguiere during his voyage round the world with Kerguelen, will be diſtinguiſhed by the name of *Bruguiera*. The ſecond, diſcovered at the Iſle of France by the ſame botaniſt, belongs to the family of the Orchis; as it is a paraſite plant that entwines itſelf around the trunks of trees, C. Lheritier means, on that account, to call it *Rhizodendrum*.

There is a tree, originally from America, the young branches of which, while in a ſtate of vegetation, are covered with a viſcous matter, which, however ſlightly touched, adheres ſtrongly to the fingers, and renders them black. C. Vauquelin conſiders it as a principle different from all thoſe known in the vegetable kingdom; but which approaches nearer to the gums than to any other ſubſtance. The production of this ſort of gum has made the name of *Robinia viſcoſa* be given to the tree in queſtion, to diſtinguiſh it from another *robinia*, or falſe acacia, to which it has a great reſemblance, femblance. C. Cels and Ventenat have fhewn that this tree belongs to a fpecies defcribed by C. Juffieu and Lamarck. We are indebted to C. Mechaut, affociate of the Inftitute, for this new acquifition, ftill more important perhaps than that of the falfe acacia, which is at prefent cultivated with fo much advantage.

The difficulty of collecting the various productions of different climates, has been juftly confidered as one of the greateft obftacles to the ftudy and progrefs of natural hiftory. This difficulty no longer exifts in regard to the plants growing in the territories of Tunis and Algiers. The public is now in poffeffion of a *Complete Flora of Mount Atlas*, fo long wifhed for by botanifts; and we are indebted for that obligation to C. Desfontaines.

C. Brouffonet, whom the love of fcience conducted to the fame part of Africa, has given an account of the particular proceffes employed at Fez and Tetuan, for preparing thofe goat fkins of which morocco leather of different colours is manufactured.

C. Teffier has fhewn how beneficial it would be to encourage, in the maritime provinces of France, the manufacturing of pitch-rope paper, fuch as that ufed for fheathing of fhips, by employing oakum procured from old ropes, &c.

The fame author has obferved a fingular fact, the caufe of which is not yet known. He obferved, in feveral places, milk newly drawn from the cow, and of a beautiful white colour, to become blue in the courfe of two or three days, and remain fo even after it had been boiled. We are affured that this phenomenon does not depend either on the age or health of the cows, on the dairies, the veffels in which the milk is preferved, nor on any want of care or cleanlinefs. The whole produce of the milk, though blue, is of a good quality, and may be ate without any inconvenience. It is not improbable that this colour may be owing to fome plants of the nature of woad or indigo, on which cows fometimes feed in fummer. But this is only conjecture; and C. Teffier propofes, proposes, with a view of discovering the truth, to make the necessary researches and experiments in those places where the phenomenon has been observed *.

In a memoir on a new classification of shells, C. Lamarck has shewn the necessity of increasing the number of genera, and of abridging the characters by which they are distinguished. This number he carries to a hundred and seventeen. Linnæus and other naturalists made it only sixty. By means of this classification, we may more easily reduce to its particular genus, all the testaceous animals with which we wish to be acquainted.

In the numerous family of the spiders there are some called miners and masons, because they construct for themselves subterranean cavities or galleries, which they shut with a kind of trap-door. C. Latreille, associate of the Institute, has pointed out the characters peculiar to this industrious family, and the means of preventing their being confounded with other insects of the same name, but of a different species.

It is well known that phosphorus, and several saline combinations of the phosphoric acid, have been found by chemists in urine. By new researches C. Fourcroy and Vauquelin have discovered, in that liquid, alumine and the phosphat of magnesia. They have seen that a peculiar animal matter, by which urine is characterised, and which gives it all its properties, forms there, very speedily, ammonia, which makes the phosphat of magnesia pass into the class of triple salts, renders it much less soluble than before, and susceptible of being precipitated in laminæ or crystalline needles. These two chemists have given an account of the spontaneous changes it experiences, and shewn that the examination of

* There seems more reason for suspecting it to be Prussian blue, the ingredients of which are furnished by all red blooded animals. We may observe, however, that it is a known fact that cows which eat the madder plant, give milk that has the appearance of being streaked with blood. Edit.

it,

it, ſcarcely begun, is one of thoſe objects which are highly deſerving of the attention of phyſicians, ſince it affords the means of reſolving one of the moſt important problems in regard to the phyſical condition of man, either in a ſtate of ſickneſs or health.

The obſervations of C. Beaumé on the decompoſition of the muriat of lime by lime (muriate calcaire par la chaux), and his reſearches in regard to a diſeaſe called by phyſicians the black bile, the cauſes and effects of which have been explained by C. Portal, in pointing out the remedies by which it may be cured, have likewiſe engaged the attention of the claſs of the phyſical ſciences.

ROYAL SOCIETY OF LONDON.

On the 5th of April the meeting was occupied with the reading of a paper on animal electricity, by Dr. Yeats. On the 12th and 18th a long paper on the Andaman Iſlands, by Capt. Blair, was read. On the 25th, ſome farther obſervations on hermaphrodites, by Everard Home, Eſq. On the 2d and 9th of May, an ingenious paper by Count Rumford, on the weight of caloric, in which he repeats Dr. Fordyce's experiments, but with various reſults; and concludes, from all the experiments, that heat is imponderable. On the 9th there was alſo read a paper on the fecundation of plants, by Thomas Andrew Knight, Eſq. On the 23d, and 30th, a paper on the different kinds of Aſiatic elephants, with obſervations on their tuſks and teeth, by John Corſe, Eſq.

DISCOVERIES IN AFRICA.

The following notice, on this ſubject, by Lalande, has appeared in one of the French Journals:

"Sir Joſeph Banks, preſident of the Royal Society of London, has received intelligence from Horneman at Grand Cairo. His laſt letter was dated the 31ſt of Auguſt. Bonaparte offered him money. He ſet out with the caravan of Fezzan

Fezzan on the 12th of September, with camels, horses and some merchandise. He assumes the character of a merchant, but not very rich, that he may not afford temptation to avarice. When in Egypt he accidentally met with a countryman of his own, who had long resided there, and embraced the Mahometan religion. He had made three journeys to Mecca, and spoke the Turkish and Arabic languages with great fluency. He was on the point of returning to Europe; but, at the request of Horneman, he consented to accompany him on his journey. Horneman means to proceed to Fezzan, and thence to Cashna. He will remain as long as he can in the interior of Africa; and return either towards the west by Senegambia, or towards the east by Ethiopia. He still enjoys good health; has withstood the climate of the country, and is filled with zeal and ardour. His letter to Sir Joseph Banks bore the impression of Bonaparte's official seal, and was delivered to Sir Joseph by the French agent in England for the exchange of prisoners. Sir Joseph, in Von Zach's Ephemerides for February, does justice to the French by a compliment for the scrupulous delivery of this letter."

The following is an extract of a letter from *M. Horneman* to *Professor Heeren* at Gottingen, dated Cairo, October 14, 1797.—"I am as well at present as can be expected; my health has not in the least suffered from the climate, though it is very different from that of Europe. I have not yet been able to examine thoroughly the ruins of Alexandria, because there are too many of the free Arabs roving about the city. But, in order that I might not be idle, I examined the different kinds of stones, and carried away specimens. It was no part of my plan to make researches into the antiquities in the neighbourhood of Cairo, until I had studied the language of the inhabitants. As I had a good opportunity, however, to visit the pyramids of Giza, I did not neglect it; and though the shortness of the time I could employ would not allow me to make many new observations, I received this benefit

benefit from the excursion, that I am better acquainted with the country, and the easiest method of travelling through it.

"I first ascended the great pyramid, and had got about a sixth part of the way towards the summit, when I was obliged to return that I might not detain my companions, M. Hope and Major Schwarz, who wished to enter it. This, however, we found impossible; because the entrance was choked up with sand, which it was necessary to remove. That we might not lose time, I proposed to Major Schwarz to take a walk through the neighbouring district, to examine the different kinds of stones. This we did with as much speed as possible, and returned in about an hour and a half. Before we came back M. Hope had been at the sarcophagus, but had again come out and returned to the vessel, which lay at the distance of about ten minutes walk from the large pyramid.

"I now intend to go back with two of Murad Bey's people, and to take a complete plan of all the pyramids, with the surrounding district, and a section of these edifices also, if possible; to go somewhat farther than other travellers have done; and, above all, to examine the springs in the large pyramid, which I consider to be difficult, but not impossible.

"Just now (Oct. 1797) is the best time for travelling in Egypt. Peace every where prevails, for all are afraid of Murad Bey. An Englishman of the name of Brown seems to have taken advantage of this favourable period. Before he proceeded to *Darfoor*, he had been in Upper Egypt; at *Siwah* (the ancient temple of Jupiter Ammon), and the Lake Natron. He remained above two years at *Darfoor* without being able to procure leave to return, until he at length obtained it by an accident. People here say that he observes great silence, and therefore they scarcely know any thing of his discoveries.

"There is at present an Abyssinian bishop here, of whom I have made several enquiries respecting Bruce. He informed me, me, that an Englishman, *Jacobo Bruce*, had been in Abyssinia; that he was in great favour with the king and nobles of the country; that he frequently observed the sun with an instrument like that used by seamen; that he often asked respecting the *Sources of the Nile*, and that he at length undertook a journey thither. The bishop said that he had not been acquainted with this traveller himself; but that his father had known him personally, and had frequently spoken of him. This worthy bishop, therefore, has cleared Bruce of the accusation made against him, that he had never been at the sources of the Nile."

Under the head of discoveries in Africa, we are happy to announce, that the Public will soon be gratified with an account of Mr. Brown's travels into that little known quarter of the world. Mr. Brown some years ago went from Cairo to *Seewah*, and in the ruins of *Oasis* there found the remains of a remarkable chapel, which he conjectures, and with some probability, to have belonged to the celebrated temple of Jupiter Ammon. He afterwards went along with the *Soudan* caravan, and paid a visit to the *Great Oasis* or *Alwah*, to which no European before him had ever penetrated; and which is laid down very accurately in Major Rennel's map, published in the *Proceedings of the African Association*. Mr. Brown then travelled through a desert of considerable extent, and at length arrived at *Darfoor*, in 15° 15′ north latitude, which stands a little to the east of *Haraza* on the map above-mentioned. Here he found two cities, lying at the distance of two days journey of a camel from each other. One of them was the king's residence; the other was inhabited by merchants. In the latter of these cities he remained two years and ten months in an unpleasant situation, as he was often ordered to attend at court, and was not suffered to go to any distance from his habitation; owing to an accident, however, he at length found means to depart, and returned by the way of Egypt and Syria.

ASTRONOMY.

The tranfit of Mercury over the fun's difk is a phenomenon of the utmoft importance to aftronomy, as it affords the means of improving the theory and tables of that planet; but the late phenomenon of this kind, which took place on the 7th of May, was deferving of the more attention, as a tranfit of Mercury at the defcending node of his orbit had never been obferved in its whole duration. Thefe tranfits, in general, are much more uncommon than thofe at the afcending nodes. Ever fince mankind began to view the heavens, Mercury had been obferved only three times under the like circumftances, and unfortunately each obfervation was incomplete. In the year 1661 the ingrefs of the planet into the fun was feen, but not its egrefs; and in the years 1753 and 1786 the egrefs only was obferved. It is much, therefore, to be wifhed that the weather had been more favourable during the late tranfit, as the fame phenomenon, under the like circumftances, will not occur before the year 1832. According to an obfervation made by a gentleman at Greenwich, on this tranfit, on Tuefday the 7th, with a feven feet telefcope by Dr. Herfchel, the aperture of which was contracted, the internal contact with the SW limb of the fun happened at $4^h\ 28'\ 32''$, and the egrefs at $4^h\ 31'\ 24''$ p. m. mean time. The ingrefs was not feen on account of the cloudinefs of the morning.

Mercury has at all times afforded much occupation to aftronomers; becaufe, to obferve that planet, is a matter of confiderable difficulty. The great Copernicus died without ever having feen it, and therefore could believe only in its exiftence. The celebrated Maeftlinus, the tutor of the immortal Kepler, ufed to fay that this planet was calculated only to expofe aftronomers to the danger of lofing their reputation: fo that when he knew of any one employed in tracing out its intricate courfe, he advifed him to employ his time on fome better

better object. Riccioli calls Mercury a false deceitful star (*sidus dolosum*), the eternal torment of astronomers, which eluded them as much as the terrestrial mercury did the alchemists *. Lalande, that respectable veteran of astronomy, who has forty-six years engaged with this celestial rebel, in his last treatise on it, in the first volume of the Transactions of the National Institute, calls its course *une orbite inextricable*. On account of this planet he studied the Greek language, that he might be able to read the old observations in Ptolomy's Almagest in the original, and, of course, to explain them better; and in the younger part of his life he used to get on the tops of the houses, before sun-rise, to have a view of Mercury above the foggy horizon of Paris. It is natural, therefore, to suppose, that, after so much labour and exertion, Lalande would have given the best tables of Mercury; and this was really the case, so far as they surpassed in accuracy the old tables of Halley and Cassini. He waited, therefore, with anxious expectation for the transit of this planet over the sun's disk on the 4th of May 1786. His observations on that occasion were to be the touchstone of his tables, and to reward him at length for the incessant pains and labour he had bestowed on them for nearly half a century. The treacherous Hermes, however, instead of sanctioning these tables, proved that the author had erred more than half an hour †. Since that time Triesnecker of Vienna, and lately Oriani of Milan, have employed themselves on this planet: and as the last, in particular, first calculated the per-

* *Almagestum*, p. 563: Nemo planetarum—Mercurio implicatior est—adeo ut cœlestis Mercurius non minus Astronomos torserit, quam terrestris Alchemistas eludat. And in another place, p. 498, he says—Non minoribus quippe spirarum involucris vaferrimus planetarum suffuratur se hic Hermes Astronomorum conatibus, quam caduceus ipsius tortuosis anguium circumflexibus.

† Lalande's own words are—*Une erreur de plus de demi-heure vint me donner un dementi.*

turbation,

turbation, according to La Place's theory; Lalande, in the year 1796, improved his elements of Mercury's orbit, and published them in the *Connoissance des Tems* for the year VII, in the certain hope and expectation that he had at length overcome this intractable planet, and could with Virgil exclaim: *Respexit tamen et longo post tempore venit.*

Much, however, was still wanting; and we are happy to inform those fond of astronomy, that a respectable astronomer, Major von Zach, has just announced a complete new set of tables of Mercury, in which not only the perturbations of Venus, calculated by Oriani, but those also occasioned by the earth in Mercury, and which Oriani has omitted, will be taken into account. An exalted amateur of astronomy is employed in calculating them, and they will be printed at his expence. Major von Zach informs us also, that he will have the pleasure of transmitting them to all the astronomers in Europe. As these tables are not intended for the booksellers' shops, every person fond of astronomy, who wishes to procure a copy of the work, will receive one gratis, on applying to Major von Zach at Gotha.

BOTANY.

A singular and ingenious method of multiplying the tongue-leaved eucomis or fritillary (*Fritillaria regia*, L.) is described in Professor Hedwig's Collection of Memoirs and Observations on Subjects of Botany and Economy. This fritillary is called, by Lamarck, *Basile à epi couronné*. When this beautiful plant of the lily kind is in full flower and vigour, the flowers, leaves, and the upper part of the bulb must be cut, and wrapped up in several folds of sized writing paper, so that the whole be exactly covered. They are then to be moderately compressed between two pieces of board; and at the end of some months several small bulbs will be seen formed at the lower extremity. I cultivate, says C. Willemet, who has made known the above observation, this charming unilobed plant in the national botanic garden at Nancy. It requires to be kept during winter in the hot-houfe.

MEDICINE.

Doctor Lentin, a celebrated phyfician of Germany, has lately publifhed, in the Tranfactions of the Royal Society of Gottingen, fome obfervations on Caries of the Bones, and the cure of that difeafe. In his opinion it depends on a chemical decompofition of the phofphat of lime, produced by the putrefaction of the gelatinous matter contained in the bones. In confequence of this idea, he was authorifed to believe that the phofphoric acid adminiftered externally might be ufeful in that difeafe; and experience, from what he relates, feems to confirm it. He gives internally from ten to twenty drops in any proper vehicle; and externally, one part of the fame acid with feven parts of diftilled water. He fays, he obferved that the peculiar fetid odour of carious bones was in a little time removed, and that a cure fpeedily followed. He, however, adds, that perfons afflicted with hemorrhoidal fymptoms, as well as women when fubject to their courfes, were a little irritated by this remedy.

Knakfted has publifhed, in the Memoirs of the Inftitute of Peterfburgh, for the treatment of the fick, that the root of common elecampane (*Inula helenium*), given both internally and externally, is a very efficacious remedy for tetters, the itch, and other cutaneous difeafes.

INDEX TO VOL. III.

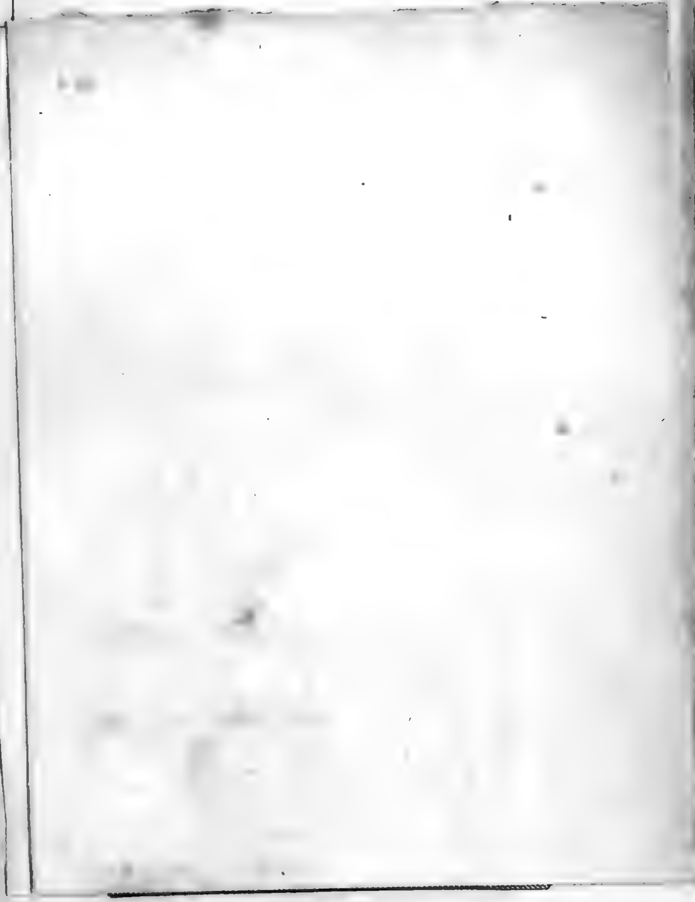
Eſſential

END OF THE THIRD VOLUME.

ERRATA.

Page 15, l. 24, for *craters* read *crater*.——P. 22, l. 22, for *carb.* 3·65, read *carb.* 3·615.——P. 23, l. 15, after *elegances*, add *of life*.——P. 25, l. 20, for *Lancaſhire*, read *Lanarkſhire*.——P. 25, l. 16, after *aſſay*, inſert *furnace*.——P. 28, l. 9, for *formed*, read *found*.——P. 29, l. 6, read, accompanying *ſchiſte* and rubbiſh.

The Binder is deſired to notice, That the Plates in No. XI. for April, are wrong numbered in ſome Copies. Plate VII. ought to be Plate VI. and the Quarto Plate marked VIII. ſhould be Plate VII.



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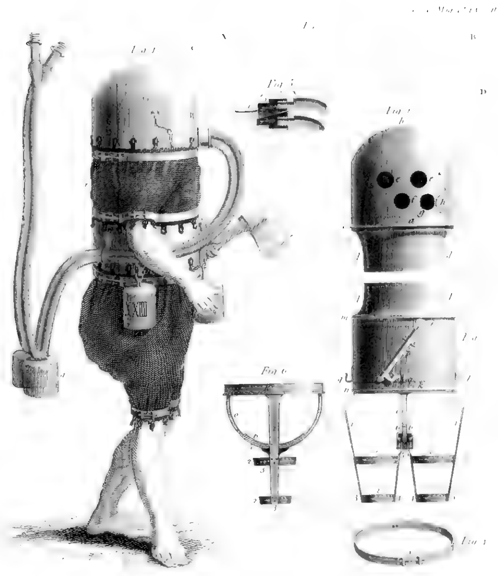


Fig 1

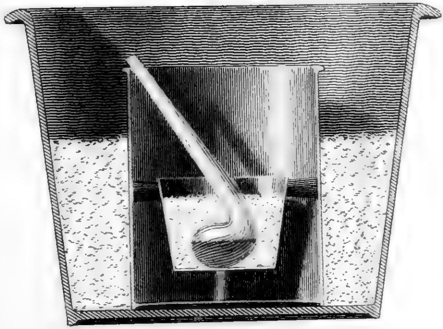
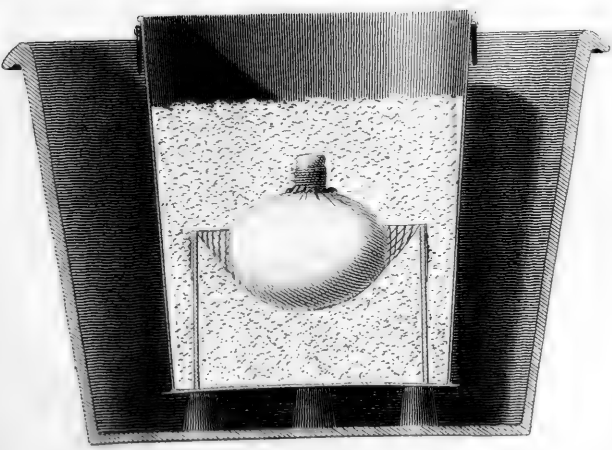


Fig 2



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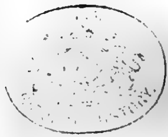

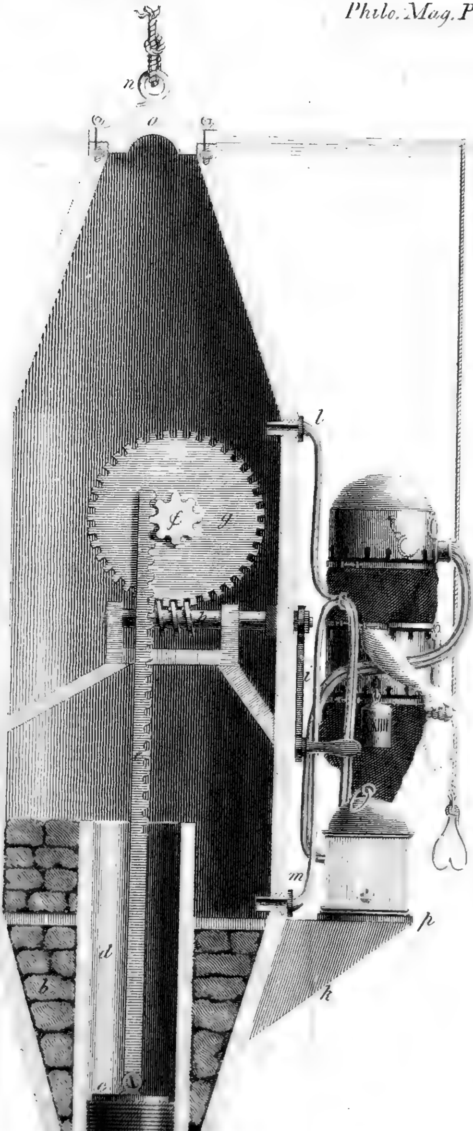

Lowry sculp.

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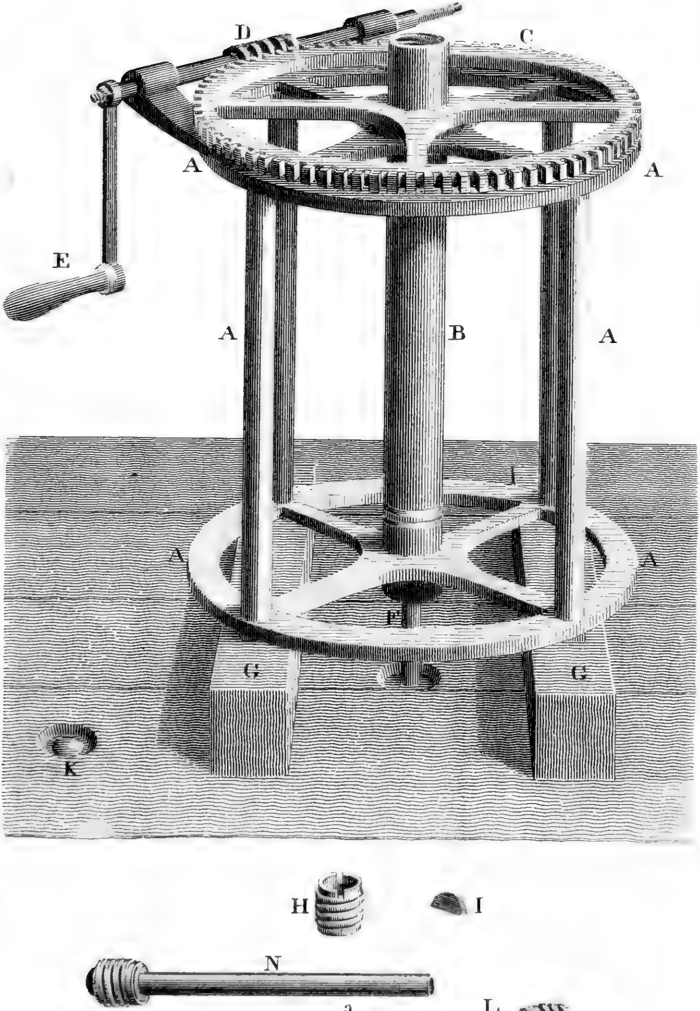
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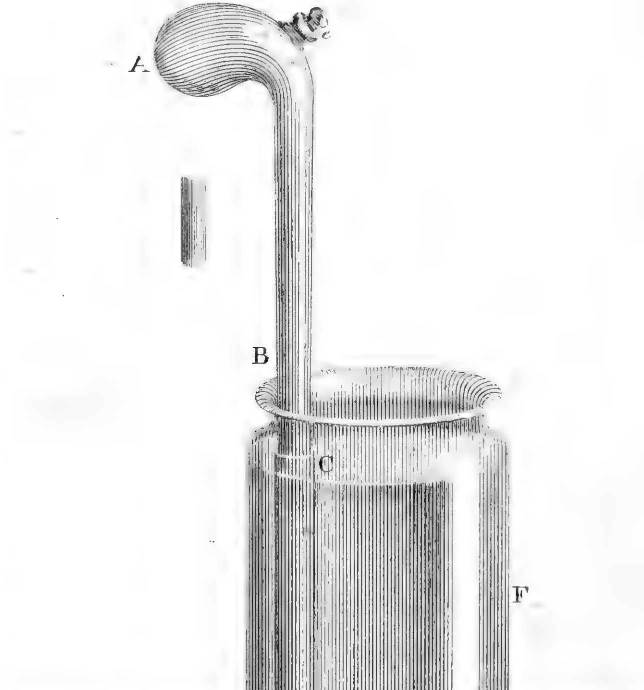

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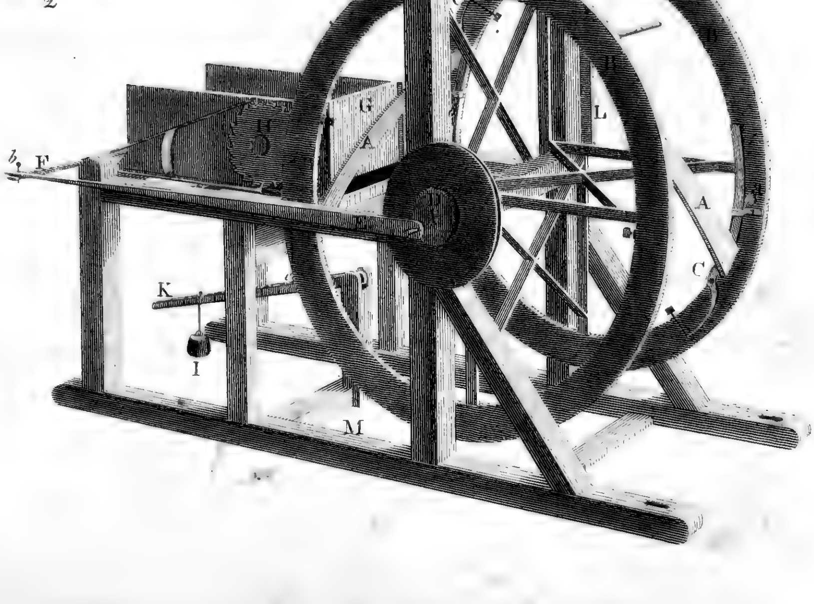
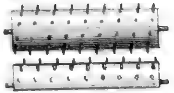
Lowry sculp

Fig 1





2

Lowry Sculp

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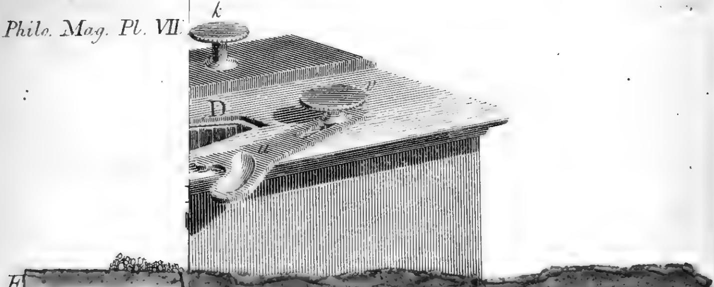

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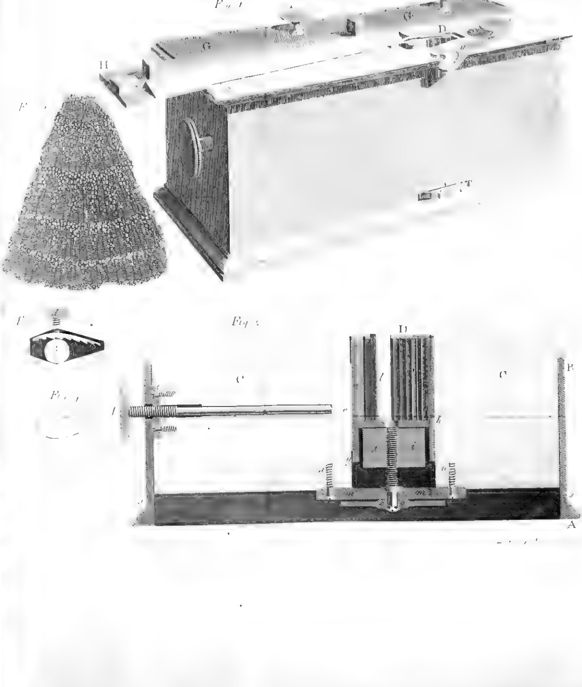
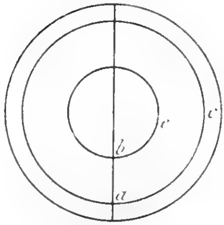


Fig. 1.

Fig. 2.



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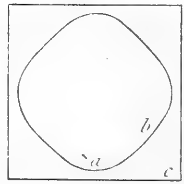

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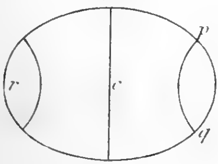
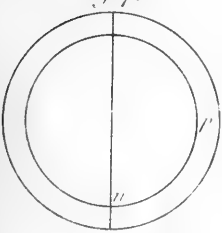


Fig. 5.

Fig. 6.

Fig. 7.



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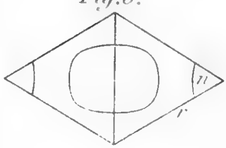

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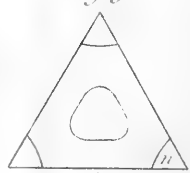

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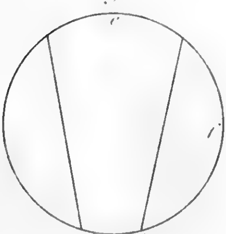

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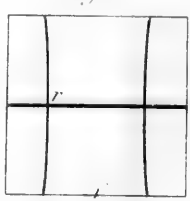

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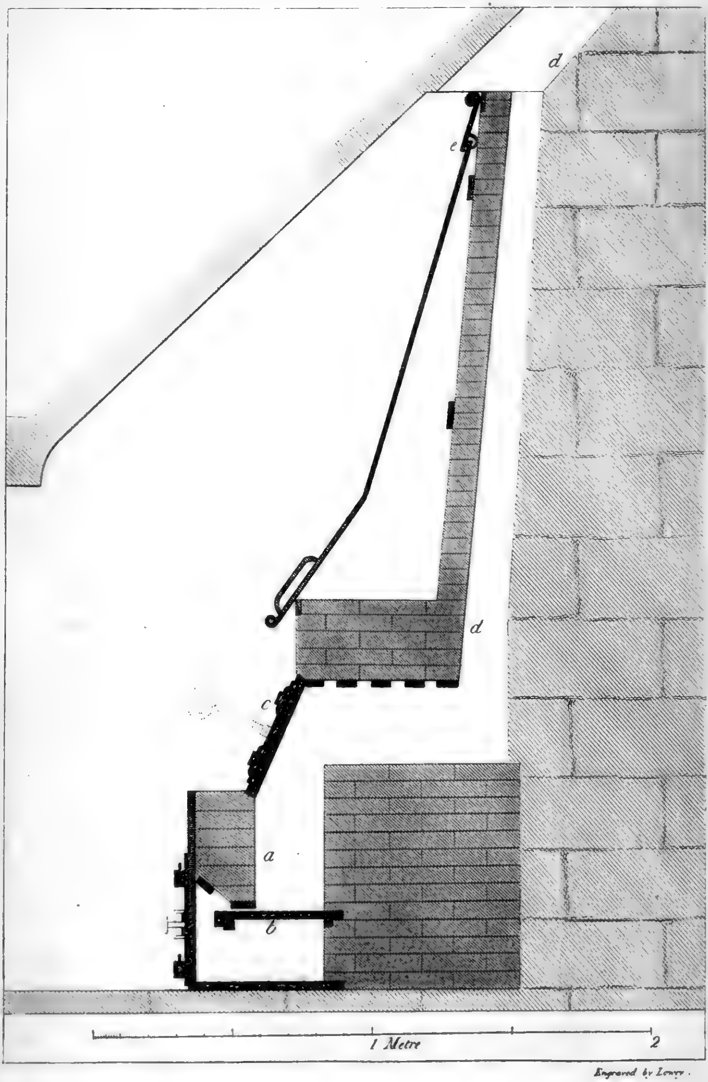

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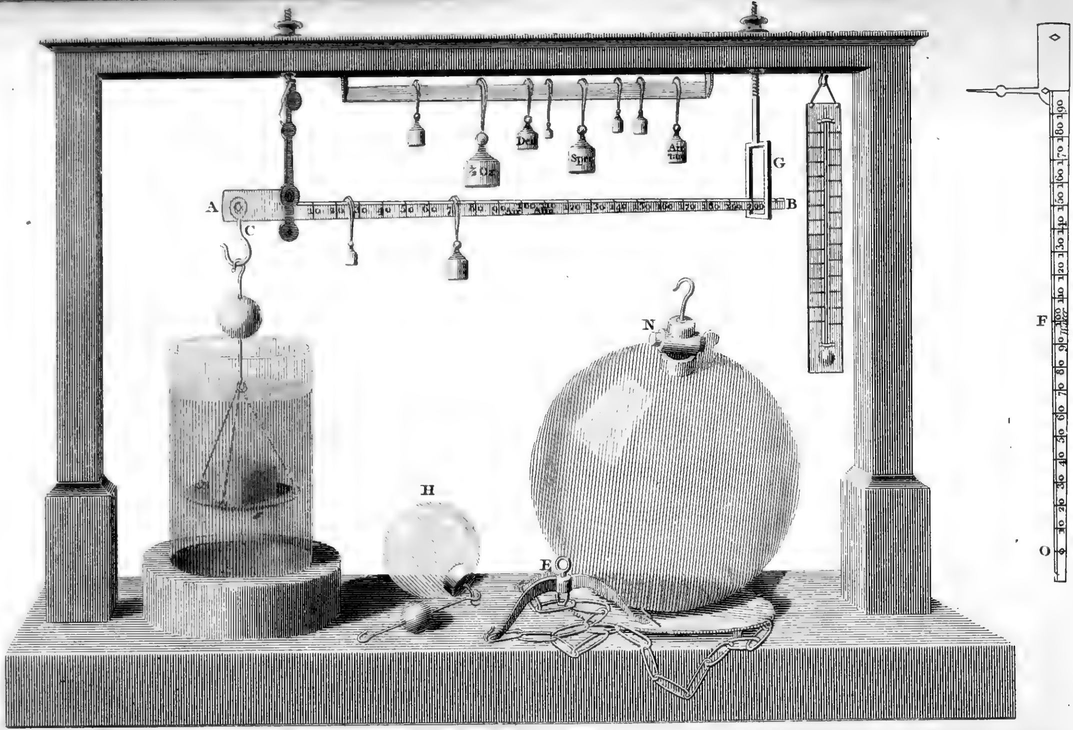

Engraved by Lowry.

and two innermost Satellites, as seen by Dr. Schröter at Lilienthal—Mr. Rupp's Apparatus for saturating Water with oxygenated muriatic Acid, for the Purposes of Bleaching, without the Addition of Alkali—Representation of a Pearly Excrescence—Mr. Cuthbertson's Apparatus for combining Hydrogen and Oxygen to form Water—the Apparatus employed by Count Rumford in his Experiments on the Propagation of Heat in Fluids—A Plate illustrating C. Hauy's new Method of expressing Crystalline Forms by short Signs—Mr. Jee's new-improved Mangle—The Instrument employed by the Hindoos for making Incisions in the Poppy to extract Opium.

Number IX. is illustrated with an Engraving of Mr. Klingert's new Diving Machine, by which a Person may descend a considerable Depth in Water, and move, walk, and work as if on dry Land—And the Apparatus employed by Messrs. Pepys and Allen in Freezing Fifty-six Pounds of Mercury by Artificial Cold; and for Freezing Acids, &c.

Communications for the Work, addressed to the Care of Messrs. CADELL and DAVIES, Strand, or Messrs. RICHARDSON, Cornhill, will meet with every Attention.

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